New Regional Industrial Path Development:
Entrepreneurs, Knowledge Exchange and Regional Contexts

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Entrepreneurs, Knowledge Exchange, and Regional Contexts

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Abstract

In recent years, new regional industrial path development has become more important than ever before due to increased competition fuelled by digitalisation and an intensifying globalisation. One way for regions to respond to this increasing global competition is to promote processes that can transform and renew regional industries, as well as processes that can create new industries within regional boundaries. Such processes of change are vital because, if there is no industrial dynamism, regional industries will eventually be outpaced by competitors and the region will face augmented economic challenges.

As the issues related to regional industrial change are of such importance, economic geographers have increasingly turned their research attention towards the issue of regional industrial development. Such processes of industrial change have been identified in the relevant literature as evolutionary and path dependent, and it has also been found that processes of regional industrial development unfold within regional innovation systems (RISs). Further, the literature found that such regional innovation systems vary in their number and diversity of actors as well as in their institutional arrangements, and argued that such regional differences will affect the ability of regions to foster and promote industrial renewal and new path creation.

However, contemporary research has met some critique. One important criticism refers to the research as being overly focused on systemic factors and less observant of the actors contributing to regional industrial change. Thus, we know relatively little about who the key actors in new regional industrial path development processes are, their distribution of roles, and with whom they interact and share knowledge for innovation. Further, we lack knowledge of how contextual factors influence such processes.

This doctoral thesis addresses these shortcomings and presents novel research that aims to shed new light on the process of new regional industrial path development. The main research question addressed in the thesis is the following: *Which key actors and mechanisms influence new industrial path development in various regional settings?*

Concerning actors, the thesis researches the role of new entrepreneurial firms and suggests a link between innovation radicalism and the ambition of the new entrepreneurial firm on the one hand and the expected effect of the entrepreneurial action to regional industrial development, on the other hand. Further, the thesis introduces the notion of system-level entrepreneurs and assesses the importance of these entrepreneurs in relation to foster industrial development. Concerning the mechanisms, the thesis identifies knowledge sourcing as a key mechanism in new regional industrial path development. It contends that the nature and geography of knowledge sourcing vary and that the expected outcomes of new regional industrial path development should be analysed in relation to the nature of the process and the actors involved in knowledge sharing activities. Finally, when addressing the role of geography, the thesis finds that new industrial path development processes vary in space, because regions are differently conditioned to foster innovativeness and knowledge sourcing activities.

The research design of the thesis is inspired by critical realism, and the empirical evidence draws from a rich selection of triangulations. The empirical cases are drawn from several regional innovation systems in Norway.

This doctoral thesis includes four articles and this ‘kappa’ (capstone paper). The four included articles are independent contributions that have either been published in peer-reviewed journals or are in the review phase. The articles research new regional industrial path development in various ways. The purpose of the kappa is to outline the overall theoretical and analytical framework as well as the methodological foundation that has informed the presented research. Furthermore, the kappa presents the overall findings and draw conclusions.

Keywords: economic geography, new regional industrial path development, firm-level entrepreneurs, system-level entrepreneurs, knowledge sourcing, entrepreneurial discovery processes, knowledge networks, regional innovation systems

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Kristiansand/Grimstad, February 19, 2018

Jan Ole Rypestøl

List of publications

This doctoral thesis includes the following four articles:

I. Rypestøl, J. O. (2017). Regional industrial path development: The role of new entrepreneurial firms. *Journal of Innovation and Entrepreneurship*, 6(1), 3. doi: 10.1186/s13731-017-0064-1

II. Rypestøl, J. O., & Aarstad, J. (2018[1]). Entrepreneurial Innovativeness and Growth Ambitions in Thick vs. Thin Regional Innovation Systems. *Entrepreneurship and Regional Development*. Forthcoming.

III. Isaksen, A., Kyllingstad, N., Rypestøl, J. O., & Schulze-Krogh, A. C. (in 2nd review). Differentiated regional entrepreneurial discovery processes. A conceptual discussion and analysis of three emergent clusters in Norway. *Regional Studies*[2].

IV. Martin, R., & Rypestøl, J. O. (2017). Linking content and technology: On the geography of innovation networks in the Bergen media cluster. *Industry and Innovation*, 1-24. doi: 10.1080/13662716.2017.1343132

[1] Accepted for publication on Feb 07, 2018.

[2] An early version of this article, entitled Entrepreneurial discovery processes in different regional contexts. A conceptual discussion, is accepted as a book chapter in: Å. Mariussen, S. Virkkala, H. Finne, & T.M.B. Aasen, (2018 forthcoming), *Unpacking the entrepreneurial discovery process – new knowledge emergence, conversion and exploitation*. London, *Routledge*.

List of acronyms

CEM	Coarsened exact matching
CR	Critical realism
DUI	Doing, using, interacting
EDP	Entrepreneurial discovery process
EE	Entrepreneurial ecosystems
EEG	Evolutionary economic geography
ICT	Information and communication technology
SI	System of innovation
KSTE	The knowledge spillover theory of entrepreneurship
LAU	Local administrative unit
MAR	Marshal – Arrow-Romer externalities
NCE	Norwegian Centre of Expertise
RIS	Regional innovation system
RIS3	Research and Innovation Strategies for Smart Specialisation
R&D	Research and development
SNA	Social network analysis
STI	Science, technology, innovation

List of tables and figures

1. Introduction

New regional industrial path development is at the core of the research agenda in evolutionary economic geography, and contemporary research in this domain builds on two lines of research. The first line roots in the early work on industrial districts introduced by Alfred Marshall (1890). This research line has subsequently been developed by concepts such as learning regions (e.g., Asheim, 1996; Florida, 1995; Morgan, 2007), innovative milieus (e.g., Camagni, 1995), cluster theory (e.g., Porter, 1998, 2000), and the regional innovation system (RIS) approach (e.g., Asheim & Coenen, 2006; Asheim & Gertler, 2005; Asheim & Isaksen, 2002; Cooke, 1992, 2001, 2002). The second line of research involves the concept of path dependency that originated in the work of Paul David and Bryan Arthur (e.g., Arthur, 1989; David, 1985). Their pioneering work demonstrated that technological development and industrial location were historically anchored, and, from their canonical model, the concept has been developed further to explain how socioeconomic systems change over time. In contemporary research within the field of economic geography, the two concepts of RISs and path dependency have been merged to form the research agenda on new regional industrial path development (Isaksen, 2015; Isaksen & Trippl, 2014, 2016; Martin, 2010; Martin & Sunley, 2006; Trippl, Asheim, & Miörner, 2016; Tödtling & Trippl, 2013).

The research in this doctoral thesis supplements economic geography with insights from entrepreneurship and innovation studies. The thesis identifies multiple gaps in this newly emerging research field. The identified shortcomings refer to all the steps of the development process, including a lack of knowledge concerning which key actors are involved, which mechanisms unfold within the processes of new regional industrial path development, and how these actors and mechanisms can be expected to influence the outcome, that is, the type of path development. Furthermore, limited knowledge exists concerning the role of geography in such processes of change.

This doctoral thesis contributes to ongoing research by shedding light on these identified shortcomings by addressing the following research question: *Which key actors and mechanisms influence new industrial path development in various regional settings?*

1.1. Structure of the thesis

This thesis consists of four articles and a kappa. The core of the dissertation comprises the four included articles that either have been published or are in the review stage in peer-reviewed journals. All the articles present novel research that enhances our understanding of new regional industrial path development. The main purpose of the kappa is to outline the theoretical insight on which the four articles draw and to describe and discuss the ontological and epistemological underpinnings of the research as well as the chosen methodological framework and methods. Finally, the main purpose of the kappa is to present and discuss the overall findings and conclusions.

Following this first chapter, the kappa contains three additional chapters. In chapter 2, an outline of the theoretical background to the concepts of knowledge, regional innovation systems, entrepreneurial discovery processes, and path dependency theory is presented. The chapter concludes with the presentation of an analytical framework that synthesises the most likely characteristics of new regional industrial path development across three different regional settings, and presents ten theory-led assumptions extracted from this framework. These assumptions inform the research questions examined in the four included articles. In chapter 3, the ontological and epistemological foundations of the thesis are presented and discussed along with the methodological framework and the methods used for the empirical research. Finally, chapter 4 presents the findings of the articles and provides a conclusion.

1.2. Aim and contribution of the thesis

In the evolutionary economic geography literature, there has been an increasing focus on exploring the evolution of regional industries from a path dependency perspective (Isaksen, 2015; Isaksen & Trippl, 2016; Isaksen, Tödtling, & Trippl, 2016; Martin, 2010; Miörner & Trippl, 2017; Neffke, Henning, & Boschma, 2011a; Trippl et al., 2016). A central argument in this line of literature is that industries embed themselves in regional settings that influence their further development (Grillitsch & Trippl, 2016; Isaksen & Trippl, 2014). Previous and contemporary research on new industrial path development has, however, mainly concerned systemic factors, while less attention has been paid to micro-level factors, such as the key actors and mechanisms involved in

such processes (Qian, Acs, & Stough, 2012; Sternberg & Muller, 2005; Uyarra, 2010). Thus, knowledge is limited concerning the role of diverse types of entrepreneurs in new regional industrial path development and the knowledge sourcing activities and interactive learning processes that contribute to such processes. Finally, knowledge is also limited regarding the mechanisms that link the initiation, development, and outcomes of new industrial path development to various regional settings. This thesis includes four articles that present novel research aiming to shed light on these identified gaps in the contemporary research literature on new regional industrial path development.

The first article (article I) addresses the role of firm entrepreneurs as initiators of new regional industrial path development processes. The article researches theoretically how entrepreneurial ambitions and innovativeness are expected to affect the future development of the relevant industry, and it introduces a novel typology with respect to entrepreneurial firms' expected contribution to regional industrial path development. The article concludes that the entrepreneurs who possess the most radical combinations of growth intention and innovativeness are in a better position to promote new path creation, while the entrepreneurs who possess the least radical combination of these factors are more likely to promote the extension of existing industrial paths.

The second article (article II) examines the role of geography to the phase of initiation of regional industrial path developments. The article researches how organisational thickness of RISs influences entrepreneurial ambitions and innovativeness. Article II researches 917 new firms and it concludes that radically innovating entrepreneurs are more frequently located in organisationally thick RISs than in thin RISs but that otherwise geography does not influence entrepreneurial growth ambitions in this study.

The third article (article III) contributes to ongoing approaches to research, as it introduces the entrepreneurial discovery process as a tool for increasing the knowledge of new regional industrial path development. The article researches three successful entrepreneurial discovery processes and investigates the key actors and the key mechanisms in such processes. Furthermore, it investigates how these processes are influenced by their contextual settings and how various entrepreneurial discovery processes affect future industrial path development. The article concludes that

entrepreneurial discovery processes shed additional light on new regional industrial path development in several ways. First, the article identifies two types of entrepreneurs as key actors: firm-level entrepreneurs and system-level entrepreneurs. Firm-level entrepreneurs are individuals who are motivated by profit opportunities and seek to exploit these opportunities by starting new innovative firms or by innovating and expanding existing firms, whereas system-level entrepreneurs are entrepreneurs whose primary aim is to build, or to improve system factors. Second, the article finds that the two types of entrepreneurial actors supplement each other and play leading roles in the initiating phase as well as during the following processes of development. Third, the article also finds that the role of system entrepreneurs is important in all geographies. Finally, it discovers that thick and diversified regions are better situated to generate processes that promote new industrial path development, while thin regions tend to promote processes that extend existing regional pathways.

Finally, the fourth article (article IV) examines the process of development in new regional industrial path development. The article researches the way in which various forms of knowledge are sourced and combined in innovation processes as well as the role of geography in such processes. Article IV investigates combinatorial knowledge dynamics in the emerging media industry in Bergen, Norway, and finds that the region is the most prominent geography for knowledge sourcing activities of all kinds. It further finds that knowledge sourcing outside the region is more frequent amongst similar knowledge based firms than among firms that hold dissimilar knowledge bases. Finally, article IV also concludes that mobility is the most localised knowledge sourcing mechanism and that monitoring is the mechanism that is the least bound to space.

In sum, the four articles address the main research question through novel research focused on the key actors and key mechanisms involved in new regional industrial path development as well as on the role of geography. Concerning the actors, this thesis moves beyond the contemporary entrepreneurship and innovation literature in two principal ways. First, it introduces a new path development firm typology that links four different combinations of entrepreneurial growth intentions and innovativeness to the expected outcomes of industrial path development. Second, it introduces the notion of system-level entrepreneurs as a supplement to firm-level entrepreneurs and examines the role of system-level entrepreneurs in processes of new regional industrial path development. The thesis argues that system-level entrepreneurs

and firm-level entrepreneurs are differently motivated and operate at distinct levels within the processes of new regional industrial path development. It finds that system-level entrepreneurs are important to development processes in all types of regions investigated, but suggests that system-level entrepreneurs are of particular importance to regions with thin RISs. The thesis further finds that regions can benefit from close interaction between firm-level entrepreneurs and system-level entrepreneurs, because the two types of entrepreneurs supplement each other as facilitators and utilisers.

When researching the key mechanisms in new regional industrial path development, this thesis finds that knowledge sourcing is a key mechanism for such processes of change. The thesis expands our existing knowledge of such mechanisms, as it introduces novel research on combinatorial knowledge dynamics within an emerging industry. It finds that knowledge sourcing can take several forms and that it can include processes of passive knowledge transfer as well as processes of interactive learning. The research on combinatorial knowledge dynamics in the media industry in Bergen concludes that the region is overall the most prominent geography for knowledge sourcing activities in this case. However, the thesis also finds that the sourcing of knowledge from outside the region is important and that such extra-regional knowledge sourcing is more prominent among partners who share the same knowledge base than among partners with dissimilar knowledge bases. The empirical findings further suggest that knowledge sourcing through monitoring is the most frequently used mechanism, while labour mobility is the knowledge sourcing mechanism that is the least frequently employed. Finally, the empirical findings indicate that mobility is the knowledge sourcing mechanism that is the most bound to geographical proximity, while monitoring is the mechanism that is the least related to spatial proximity.

Finally, when referring to the role of regional settings in industrial path development, the thesis finds that regions are differently conditioned to facilitate and promote such processes. Specifically, processes that lead to more of the same are the most realistic alternative for thin RISs. This stems from the fact that thin RISs are low in actors, in general, and in knowledge creating organisations, in particular. The thesis further discovers that thick and specialised RISs tend to promote intra-path changes as the outcome of new regional industrial path development. Intra-path changes are the most likely outcome since thick and specialised regions are both tailored organisationally and institutionally to support the existing industries. Finally, the thesis finds that the

introduction of new solutions and industries regionally are most likely to be found in thick and diversified RISs due to low barriers to combinatorial knowledge dynamics and favourable conditions for promoting radical innovations.

1.3. Overview of the articles

This paragraph presents the four articles included in this dissertation. The presentation includes the title, the main contribution, and the abstract as well as the authorship and status of publication.

Article I
Title: Regional industrial path development: The role of new entrepreneurial firms
Author: Jan Ole Rypestøl[3]
Main contribution: A conceptual paper advocating and presenting a typology of new entrepreneurial firms' expected effects on regional industrial path development
Progress: Published (Published online 13. February 2017)
Journal: *Journal of Innovation and Entrepreneurship* 6, 3 (2017)
Abstract: Entrepreneurs play an important role in the evolutionary process of regional industries. As founders of new firms, entrepreneurs increase the supply side of the industrial economy, and by doing so, they challenge the incumbent firms to respond. From the perspective of evolutionary economics, understanding these dynamics of entrepreneurial triggers and industrial firm responds are important, as it sheds new light to our understanding of how regional industries evolve. The entrepreneurship literature offers several classifications which are helpful in distinguishing between different types of entrepreneurs and firms. However, none of these classifications and typologies are suitable for explaining what effect new entrepreneurial firms may be expected to have on regional industries and their future development. This paper seeks to address this knowledge gap. Based on two dimensions, innovation novelty and entrepreneurial growth intention, the conceptual framework develops a typology of new entrepreneurial firms' expected effect on future regional industrial development. In doing so, the paper contributes to the field of evolutionary economic geography by introducing a new perspective on entrepreneurial firms' contribution to dynamic regional industrial path development. Keywords: Regional development, Entrepreneurship, Path dependency, Typology, Innovation novelty, Growth intentions

[3] This paper is single authored

Article II
Title: Entrepreneurial Innovativeness and Growth Ambitions in Thick vs. Thin Regional Innovation Systems
Authors: Jan Ole Rypestøl and Jarle Aarstad[4]
Main contribution: Researches whether RIS geography influences entrepreneurial innovativeness and growth ambitions.
Progress: Accepted for publication (Accept date: 7. February 2018)
Journal: *Journal of Entrepreneurship and Regional Development*
Abstract: Research in economic geography has paid increasing attention to regional innovation systems (RISs) as a potential vehicle for growth and development. Yet despite an increasing amount of research studying RISs in particular and economic regions in general, we have limited knowledge about their influence on entrepreneurs and entrepreneurship. We respond to this knowledge gap and study if entrepreneurs' localization in thick vs. thin RISs affects their innovativeness and growth ambitions. Thick RISs are predominately urbanized spaces that include organizations of higher-level education, R&D intensive milieus, and an ample industry sector, while thin RISs to a lesser degree encompass these features. Empirically, we analyse 870-917 entrepreneurial firms in Agder of Southern Norway. Based on trade and labour markets, as defined by the EU's classification of local administrative units (LAU1), we identify two thick and six thin RISs in Agder. Econometric analyses show that entrepreneurs located in thick RISs are more innovative than entrepreneurs located in thin RISs, but there are no significant differences concerning entrepreneurs' growth ambitions. In light of our findings, we discuss the potential agency role played by entrepreneurial firms at a micro level on path dependent features of RISs at a macro level. Key words: Regional innovation systems (RISs), entrepreneurship, innovation, growth ambitions, spillovers, robust ordinal logistic regression, bootstrapping, coarsened exact matching (CEM)

[4] The overall contribution by the authors is distributed in a 60%-40% ratio in favour of the lead author. A signed co-author declaration that provides a brief description of the contributions of the authors has been provided in accordance to section 10.1 in the Regulations for the degree of PhD at the University of Agder.

Article III
Title: Differentiated Regional Entrepreneurial Discovery Processes. A Conceptual Discussion and Analysis of Three Emergent Clusters in Norway
Authors: Arne Isaksen, Nina Kyllingstad, Jan Ole Rypestøl, and Ann Camilla Schulze-Krogh[5]
Main contribution: The paper aims to add to the literature on entrepreneurial discoveries and regional industrial development in three ways. Firstly, it aims to provide a better understanding of the way in which different regional contexts affect entrepreneurial discoveries. Secondly, the paper conceptually links regional contexts, entrepreneurial discoveries, and regional industrial path development. Thirdly, it tries out one approach to studying entrepreneurial discoveries by focusing on key actors and regional innovation system changes that initiate cluster-building processes.
Progress: In second review (Submitted May 2017 and resubmitted October 2017)
Journal: Regional Studies
Abstract: This paper aims to contribute to better understanding of entrepreneurial discovery processes and regional industrial growth by examining (a) how different regional contexts affect entrepreneurial discoveries, and (b) how entrepreneurial discoveries support specific types of industrial path development in different regions. The paper includes empirical studies of the formation and growth of three "official" regional clusters supported by Innovation Norway's programme for immature clusters. The paper argues that entrepreneurial discoveries should be institutionalised (by system-level entrepreneurs) to achieve considerable regional industrial effects. In our cases, institutionalisation occurs through the creation of cluster organisations and development of the knowledge infrastructure', Isaksen, Kyllingstad, Rypestøl & Schulze-Krogh. Keywords: Entrepreneurial discovery processes

[5] The authors are listed alphabetically. The paper is based on equal contributions by the respective authors. A signed co-author has been provided in accordance to section 10.1 in the Regulations for the degree of PhD at the University of Agder.

Article IV
Title: Linking content and technology: On the geography of innovation networks in the Bergen media cluster
Authors: Roman Martin and Jan Ole Rypestøl[6]
Main contribution: Analyses combinatorial knowledge dynamics from a single-cluster perspective
Progress: Published (Published online 23. June 2017)
Journal: *Industry and Innovation*
Abstract: This paper deals with the geography of innovation networks and analyses combinatorial knowledge dynamics from a single cluster perspective. Addressing firms in the media cluster in Bergen, Norway, we examine how and from where companies acquire and combine different types of knowledge for their innovation activities. The empirical analysis, which is based on structured interviews with 22 media companies, identifies two main types of cluster firms: media content providers that rely heavily on symbolic knowledge and media technology providers that draw mostly on synthetic knowledge. Even though they draw on different knowledge bases, the two types of firms are strongly interlinked in their innovation activities and source knowledge from each other. Furthermore, we find that synthetic firms constitute a gateway to the regional R&D system and that the region acts as key arena for the combination of dissimilar knowledge bases. Keywords: Innovation networks, knowledge bases, creative industries, new media, Norway

[6] The authors are listed alphabetically. The paper is based on equal contributions by the respective authors. A signed co-author declaration has been provided in accordance to section 10.1 in the Regulations for the degree of PhD at the University of Agder.

2. Theoretical insight

This thesis aims to advance knowledge of new regional industrial path development by researching which key actors and mechanisms influence such processes in various regional settings. This chapter presents the theoretical insight that has guided this research and structures the informing literature into four theoretical building blocks. These building blocks are; a) the concept of knowledge as the most important input for innovation; b) the regional innovation system approach as the systemic context in which new regional industrial development unfolds; c) the concept of entrepreneurial discovery processes, which includes the stage of initiation and the following change process; and, finally, d) the notion of path dependency as the theoretical concept relevant to the study of the expected outcome of new industrial development. Before presenting these concepts, however, I start by defining how this thesis understands the notion of regions and the phenomena of innovation.

2.0. Definitions

When synthesising the previous literature on methodological approaches to regions, Gilbert (1988) offered three main conceptualisations. First, regions can be conceptualised as geographies of cultural identification, second, as a local response to capitalist processes, or third, as medium for social interaction. Moving forward from Gilbert`s conceptualisation, Paasi (2002) argued that an analytical distinction can be made between regions as spatial units identified for practical reasons (a pre-scientific view of regions), as geographies identified by formal or functional classifications of empirical elements (the discipline-centred view of regions), or as geographies that are part of a wider cultural, political, or economic network (critical approaches to regions). Thus, from a geographer's point of view, regions can be conceptualised from a variety of different angles.

In this doctoral thesis, the term region refers to a sub-national geography, most often defined by functional criteria. Nevertheless, the term represents a geography that is not always framed by objective and generally accepted boundaries, as is the case when the term refers to geographical areas, like 'southern Norway'. However, in this thesis, regions also include geographies framed by accepted boundaries, such as counties or

the EU classification of local administrative units (LAU1). This way of dealing with the term *region* resonates with contemporary research in the fields of innovation studies and economic geography (Asheim & Gertler, 2005; Isaksen, 2015; Isaksen & Trippl, 2017a).

Furthermore, the thesis defines the term 'innovation' in accordance with the *Oslo manual*, which describes innovation as 'the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations' (OECD/Eurostat, 2005, p. 46). This definition separates innovation from inventions. While inventions include the creation of new or significantly improved solutions, innovations are understood as inventions that are put into practice and commercialised in the marketplace. Put differently, an invention represents solely the exploration phase, while innovation also includes the phase of exploitation. Thus, all innovations have to represent a degree of novelty.

One way of distinguishing between degrees of novelty in innovation is represented by the dichotomy of incremental vs radical innovation (Fagerberg, 2005). The literature defines incremental innovations as step-by-step improvements to existing products, services, processes, or ways of organising, while radical innovations represents totally novel solutions and 'can be defined as an innovation that has a significant impact on a market and on the economic activity of firms in the market' (OECD/Eurostat, 2005, p. 58). A second alternative introduces geography as a scale to distinguish between degrees of novelty and argues that innovation can be either new to the firm (but known to the rest of the world), new to the market (but known in other markets), or new to the world (op.cit).

2.1. The knowledge concept and its geography

The innovation literature has generally agreed that knowledge is the most important input for innovation and further that knowledge comes in several forms with different degrees of sensitivity to various forms of proximity (Boschma, 2005; Martin & Moodysson, 2013). In the following sub-section, I will examine in greater depth the

phenomenon of knowledge, its geography, and the way in which knowledge is created and shared.

2.1.1. Theoretical roots

The concept of knowledge has been analysed, described, and explained from a variety of angles since antiquity. The first person known to deal with epistemological questions was Plato (428BC–348BC), who argued that impressions of things are a subjective way of understanding the world. In his *Dialogues*, Plato asserted that truth is something beyond our self and that knowledge can be understood as justified true beliefs which can be reached through speculation.

Aristotle (384 BC–322 BC), who was a student of Plato, did not fully agree with his master when it came to epistemological questions. According to Aristotle, knowledge includes more than justified true beliefs, or *Epistêmê* to use Plato's term. According to Olav Eikeland (2008), Aristotle argued that the concept of knowledge is more finely distinguished and that it includes (at least) seven facets. The best known of these are *Technê,* which is commonly understood as practically applied knowledge, and *Phrònêsis*, which is commonly understood as practical wisdom.

This divide in the understanding and interpretation of knowledge is still evident today. While most natural sciences, with roots that can be traced back to Plato, follow a positivistic approach to methodically uncover true knowledge, the social sciences are more divided in their approach to knowledge and truth. Some approaches within the social sciences argue that such sciences should seek unambiguous facts, evidence, and rules, like the natural sciences, while others argue that universal knowledge does not exist and that the natural sciences should not be a role model for the social sciences. These epistemological positions are most often referred to as positivism and constructivism (Guba & Lincoln, 1994). I examine this divide further in the methodology chapter of this thesis but, for now, I conclude that the questions of what knowledge is and how we can classify various forms of knowledge date back to Greek philosophy and form the epistemological foundation of the social sciences.

2.1.2. Knowledge and innovation

As knowledge is the most important resource in innovation, it becomes important to understand how the characteristics of various types of knowledge differ. This is particularly important if one wishes to understand how knowledge in different forms should be taught, shared, and transferred. Several classifications of knowledge have been introduced over time, some inspired by Plato and Aristotle, and others placing greater emphasis on other aspects of the concept of knowledge, which are not rooted in antiquity.

One way of classifying knowledge is the dichotomy of tacit vs codified, as introduced by Polanyi (1967). This classification highlights the existence of two dimensions of knowledge, one of which can easily be communicated and shared while the other is experience-based, tacit, and not easily expressed. In the literature, explicit knowledge is recognised as the type of knowledge that can be 'captured' and described by using words, text, formulas, diagrams, and so on. As such, codified knowledge can easily be transferred geographically and stored in books, tape recordings, or elsewhere. However, as stated by Polanyi (1967, p. 4), 'we know more than we can tell'. This statement indicates that there is an additional type of knowledge, which is difficult to express and make explicit. Polanyi named this 'tacit knowledge' and argued that explicit and tacit knowledge are interwoven. As tacit knowledge is so important, he argued, it also constitutes an important element of science: 'The declared aim of modern science is to establish a strictly detached, objective knowledge … [but if] tacit thought forms an indispensable part of all that knowledge, then the ideal of eliminating all personal elements of knowledge would, in effect, aim at the destruction of knowledge' (op.cit., p. 20).

A more finely differentiated scale of knowledge categorisation was introduced by Lundvall and Johnson (1994) as the 'know-what', 'know-why', 'know-how', and 'know-who' typology. In short, the authors argue that 'know-what' refers to information which is knowledge about facts, 'know-why' refers to scientific knowledge of laws of motion in nature or science, while 'know-how' refers to skills. Finally, the authors define the 'know-who' type of knowledge as; 'to know who knows what and can do what and to have social relations to those who know relevant things' (Lundvall & Johnson, 1994, p. 112). Lundvall and Johnson argued that the four types of knowledge need to be addressed in different ways. While the 'know-what' and

‘know-why’ types of knowledge can be obtained in codified form, the other two forms need to be obtained by practical experience.

In 2005, Asheim and Gertler introduced the knowledge base typology to the community of innovation researchers as an alternative understanding of the various types of knowledge involved in innovation (Asheim & Gertler, 2005). Based on the work of Laestadius (1998), Asheim and Gertler described how innovation activity is built on two types of knowledge and introduced the knowledge base typology as consisting of the analytical and the synthetic knowledge base. Asheim (2007) added a third category, named the symbolic knowledge base, to this typology. A knowledge base consists of the type of knowledge that is vital for innovation, and it is typically described within the boundaries of industries, sectors, or innovation networks (Asheim & Gertler, 2005; Martin & Moodysson, 2013; Tödtling, Asheim, & Boschma, 2013). The concept of knowledge bases describes analytical knowledge based industries as relying mostly on scientific knowledge in their innovation processes. Such knowledge is recognised as mainly being R&D based, universal, and easily codifiable. Firms or industries with roots in the analytic knowledge base typically rely on the creation of formally organised knowledge. Such processes include knowledge exploration undertaken either by internal R&D departments or by external R&D organisations. Firms in such analytical knowledge based industries tend to focus their research on solving the ‘know-why’ question, and typical analytical knowledge based industries are those involving biotechnology and nanotechnology (Asheim, Boschma, & Cooke, 2011).

Industries that are dominated by a synthetic knowledge base, on the other hand, rely more on the experience-based engineering type of knowledge in their innovation processes. In synthetic knowledge based industries, R&D is, therefore, less important and the knowledge creation process is more informal and incremental, often focusing on problem-solving in close interaction with customers and suppliers. In synthetic knowledge based industries, the tacit element of knowledge is more evident, and the main question to be answered in such industries is the ‘know-how’ question. A typical synthetic knowledge based industry is mechanical engineering. Finally, the typology argues, firms and industries can hold a symbolic knowledge base. Symbolic knowledge based industries rely heavily on art-based knowledge, which focuses on aesthetic qualities, symbols, images, and intangible elements. Innovation in symbolic industries is typically recognised as a creative process whereby ‘knowledge is

incorporated and transmitted in aesthetic symbols, images, designs, artefacts, sounds and narratives' (Asheim, 2007, p. 226). Such processes can include 'the creation of alternative realities and expression of cultural meaning by provoking reactions in the minds of consumers through transmission in an affecting, sensuous medium' (Asheim, Grillitsch, & Trippl, 2017, p. 430). Typical industries in this regard include media, design, and cultural production.

The typology of knowledge bases has also been applied to the examination of differences in innovation networks and the geography of innovation. Studies have found that the process of knowledge exchange differs systematically between industries dominated by the various types of knowledge bases (Martin, 2013; Martin & Moodysson, 2013). These studies have shown that analytic knowledge based industries tend to be more inter-regionally active and more linked to universities and other R&D organisations, while synthetic knowledge based industries are more value chain-oriented and more geographically bounded in their knowledge exchange (Martin & Moodysson, 2013). Finally, research has found that symbolic knowledge based industries are mostly focused on close interactions within a regional setting, as symbolic knowledge is highly sensitive to the sociocultural context (op. cit.).

In 2007, Jensen, Johnson, Lorenz, and Lundvall (2007) introduced two ideal type modes of innovation, namely the Science, Technology and Innovation (STI) mode and the Doing, Using and Interacting (DUI) mode. The two ideal type modes of innovation acknowledge that knowledge exists in different forms and that learning and innovation are therefore facilitated differently. Building on the notion that knowledge can be either explicit or implicit and either local or global, and further, that knowledge is learned differently depending on whether the purpose of learning is to 'know-what', 'know-why', 'know-how', or 'know-who', Jensen and colleges argued that the STI and the DUI mode of innovation are fundamentally different. The STI mode of innovation typically relies on explicit and global knowledge, which aims to explain the 'know-what' and the 'know-why' types of questions, while the DUI mode of innovation relies more on the implicit and local types of knowledge, which are conditioned to answer 'know-how' and 'know-who' questions. However, as these contrasting modes of innovation are ideal types, we should note that firms and industries rarely depend exclusively on one of the modes but most often combine the two alternatives (Isaksen & Karlsen, 2011).

2.1.3. The proximity dimension of knowledge

From the above arguments that knowledge exists in different forms and that industries rely on different knowledge bases, one can conclude, in line with Martin and Moodysson (2013), that geographical proximity is most important to innovation processes within symbolic knowledge based industries, less important to innovation within synthetic knowledge based industries, and least important to industries that innovate based on analytical knowledge. However, even though geographical proximity is important, physical proximity alone is not enough to facilitate knowledge exchange. The literature has argued that proximity is a multidimensional concept that extends beyond geographical co-location (Torre & Gilly, 2000; Morgan, 2004), and Boschma (2005) distinguished between four proximity dimensions beyond geographical co-location. These are cognitive, organisational, institutional, and social proximity. Cognitive proximity refers to the proximity of knowledge used for innovation purposes and can be identified as the proximity of knowledge that the innovating partners held before the exchange of knowledge began (Mattes, 2012). Boschma (2005, p. 63) asserted that 'as a rule, firms search in close proximity to their existing knowledge base, which provides opportunities and sets constraints for further improvement'. Thus, cognitive proximity implies that firms are more likely to exchange knowledge and learn from actors who share a related knowledge base and experience. Other types of proximity, beyond the geographical and cognitive types, are organisational proximity, which relates more to the degree of firm internalisation, institutional proximity, which addresses the formal and informal institutional framework, and finally the social proximity dimension, which refers to trustworthy relations built over time like for example friendship, kinship, and common experience.

Building on this notion of several types of proximity, later research has argued that some dimensions of proximity (to some extent) can compensate for restrictions of other types of proximity. Examples of such substitutions can be found in the work of, for example, Hansen and Løvås (2004), who concluded that social proximity can compensate for lack of geographical proximity, as their study showed that collaboration over distance is more evident among individuals who are socially related. Further evidence of proximity compensation was suggested by Kogut and Zander (1992), who found that knowledge is more easily shared between individuals

within the same firm. Other timelier examples have been presented, for example, by Hansen (2015) and Menzel (2015).

Another alternative to compensate for lack of geographical proximity is to introduce temporary geographical proximity (Rychen & Zimmermann, 2008; Torre, 2008; Torre & Rallet, 2005). Temporary geographical proximity can be introduced through impermanent spatial co-locations of actors, and such temporary spatial co-locations can be beneficial to increasing knowledge sharing activities which can enhance innovation. However, as stated previously, geographical proximity is neither a sufficient nor a necessary condition for innovation (Boschma, 2005).

Mattes (2012) argued that the various forms of proximity can be classified into two dimensions, in which the cognitive, organisational, and institutional proximity dimensions provide the foundation for collaboration while geographical and social proximity should be understood more as reinforcing dimensions. The reinforcing dimensions of proximity, Mattes stated, are by themselves unable to constitute knowledge sourcing activities. She further argued that there is a close link between knowledge bases and the five types of proximity that were introduced and she concluded that cognitive proximity is fundamental to the interactive learning processes in all the knowledge bases. In addition, she found that organisational proximity is the dominant form of integration in analytical knowledge, that institutional proximity is dominant in synthetic knowledge, and, finally, that geographical and social proximity are critical to symbolic knowledge. She further stated that geographical proximity, albeit not decisive in itself, 'carries with it a reinforcing power which triggers the other types of proximity. In essence, it acts as a facilitator for the creation of further proximities, and it is generally an enabler for closer interaction and interconnections' (Mattes, 2012, p. 1090). From this, it can be argued that, as a general rule, the region is the geography that is expected to be the most favourable to innovation activities.

Recently, a more dynamic turn in proximity research was introduced by the work of Balland, Boschma, and Frenken (2015). In short, their argument is that proximity has been treated as a static phenomenon, while in fact, one would expect various forms of proximity to co-evolve. An example is the traditional understanding of knowledge collaboration linkages in which collaboration has been explained from proximity (Boschma, 2005; Boschma & Frenken, 2011, 2012; Nooteboom, 2000). However, one would expect the causal arrows to point in both directions, as collaboration most

definitely will increase various other forms of proximity. By addressing the notion of proximity co-evolution, they found that such co-evolutionary dynamics exist between various forms of proximity occurring within knowledge networks and that such dynamics are evident for all five types of proximity proposed by Boschma (2005). The authors pointed to Padgett and Powell (2012, p. 6), who stated that 'in the short run, actors create relations; in the long run, relations create actors' and paraphrased this statement when arguing 'that in the short run, proximity creates knowledge networks, in the long run, knowledge networks create proximity' (Balland et al., 2015, p. 5).

2.1.4. Absorptive capacity

Even though new knowledge is crucial to innovation, being exposed to new knowledge is not a sufficient condition for innovation. Cohen and Levinthal (1990) addressed this issue and asserted that 'the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends is crucial to its innovative capabilities' (Cohen & Levinthal, 1990, p. 128). They labelled this capability to recognise, assimilate, and apply external information as the absorptive capacity of the firm, and they further argued that such capacity is built as an evolutionary process anchored in the history of the firm. As such, building absorptive capacity is an accumulative process. This accumulative nature suggests that, if the gap between existing firm knowledge and newly available knowledge is too wide, the firm will not be able to utilise this new knowledge for innovation purposes. This is because new knowledge has to be related to what the firm already knows to become useful. Thus, as argued previously, some form of cognitive proximity is needed for innovation and interactive learning to take place. Noteboom (1999) suggested that an inverted-U shape exists in the relationship between cognitive distance and innovation performance, as too little difference in exchanged knowledge will give no learning effect and no innovation, while too much cognitive difference will be harmful, as such knowledge is useless to innovation because of the lack of absorptive capacity (Nooteboom, 1999; Nooteboom, Van Haverbeke, Duysters, Gilsing, & van den Oord, 2007).

2.1.5. Related and unrelated varieties of knowledge

As described above, some form of cognitive proximity has to be present among firms if they are to learn from each other. Thus, the new type of knowledge has to relate to the existing knowledge in some way to become useful. The literature has researched the importance of related and unrelated knowledge for innovation (Boschma, 2017; Castaldi, Frenken, & Los, 2015; Frenken, Van Oort, & Verburg, 2007) and found that related knowledge combinations support incremental innovation due to their cumulative nature. Unrelated knowledge sharing, on the other hand, holds the potential to enhance more radical innovations, like technological 'breakthroughs' (Castaldi et al., 2015), because unrelated knowledge is detached. However, as described previously, if the unrelated knowledge is to be useful, absorptive capacity for such a type of knowledge has to be present. If it is not evident, unrelated knowledge sharing is useless (Nooteboom, 1999; Nooteboom et al., 2007).

2.1.6. Knowledge sourcing mechanisms

An increasingly important topic on the research agenda concerns how, and from where, companies acquire and combine different types of knowledge for their innovation activities. According to Tödtling, Lehner, and Trippl (2006), knowledge sourced for innovation can be distinguished along two dimensions of knowledge interactions, those of formal vs informal and static vs dynamic. The formal vs informal dimension refers to the degree of official interactions, while the static vs dynamic dimension concerns whether or not interactive learning is involved. In this typology, static knowledge interactions describe a one-way transfer of information from one part to another, while the dynamic exchange of knowledge recognises a two-way learning process. This typology of various knowledge interactions was also applied by Trippl, Tödtling, and Lengauer (2009), who found that both formal and informal knowledge transfer were highly significant on all spatial scales in the Vienna software industry and further that these informal knowledge transfers were complemented by more formalised R&D partnerships.

An alternative classification of knowledge sources was provided by Martin and Moodysson (2011, 2013), who distinguished between labour mobility, monitoring, and

collaboration as three alternative routes for firms to source knowledge for innovation. Labour mobility as a knowledge sourcing mechanism includes the movement of individuals between organisations, while the monitoring mechanism refers to as observation of innovation activities carried out by other organisations (Martin and Moodysson 2013). Such monitoring activities can be carried out by the use of various channels like Internet searches, magazines, trade fairs and more. Finally, collaboration as a knowledge sourcing mechanism refers to as inter-organisational activities which include 'reciprocal relationships which lead to bidirectional flows of knowledge' (Martin & Rypestøl, 2017, p.4).

2.1.7. Remaining questions

Even though research questions related to knowledge sources and knowledge sourcing mechanisms are raising their position on the innovation network research agenda, we still know little about the geography of such mechanisms, specifically whether or not different network channels entail different geographies. Further, it is evident that research on knowledge transfer and innovation networks tends to focus more on formal collaborative interactions (Fitjar, Huber, & Rodríguez-Pose, 2016; McKelvey & Rake, 2016), while research on non-collaborative knowledge exchange is less prominent.

Another largely unexplored theme relates to the combinatorial knowledge dynamics in innovation. Even though contemporary research has found that firms most often combine knowledge bases in their innovation activities (Manniche, Moodysson, & Testa, 2016), the dynamics and the geography of such combinatorial knowledge sharing activities are still an under-studied subject in economic geography and innovation studies. In November 2017, a special issue was published on this highly important matter in *Economic Geography* (Asheim et al., 2017). The special issue highlighted the importance of knowledge combinations for regional innovation and development dynamics, and the articles specifically addressed the importance of exogenous sources and policy interventions (Isaksen & Trippl, 2017a), a regionally balanced endowment of knowledge bases (Grillitsch, Martin, & Srholec, 2016), favourable micro-level knowledge dynamics (Manniche et al., 2016), and a well-

developed symbolic knowledge base (Strambach, 2017) to fuel such processes in various regional settings.

2.1.8. How this thesis addresses the remaining questions identified

The above-mentioned shortcomings are addressed and researched by article IV in this thesis. In this article, my co-author and I research combinatorial knowledge dynamics among 22 cluster firms within the emerging industry of media firms in Bergen. The media industry in Bergen experienced a shift in 1992 as the new location of the headquarters of Norway's second public broadcasting channel (TV2). The location of this significant media actor within the region provided local and regional firms with new opportunities and thus initiated a process that included increased entrepreneurial activity and a significant change in the regional innovation system. The study finds that this emerging industry consists of two types of firms that collaborate in their innovation processes, those of media content providers and technology providers. Our study investigates the knowledge bases of these firms, and we find that content-providing firms and technology-providing firms rely on different knowledge bases in their innovation. While technology providers rely heavily on synthetic knowledge, content providers are dominated more by symbolic knowledge. The article investigates how these two groups of firms source knowledge both among and between each other and with additional actors inside and outside the region. The study focuses on three knowledge sourcing mechanisms and researches their spatial sensitivity.

2.2. Regional innovation systems

A key finding in innovation research is that firms seldom innovate in isolation (Fagerberg et al., 2005). Thus, innovation is mainly understood as an interactive phenomenon, which includes knowledge sourcing activities between various types of actors, both regionally and beyond (Asheim & Isaksen, 2002; Edquist, 1997; Fagerberg, 2005; Martin & Moodysson, 2013). This interactivity is at the core of the regional innovation system approach.

2.2.1. Theoretical roots

The interactive nature of innovation is a precondition for the system of innovation (SI) approach (Edquist, 1997, 2001). The approach was introduced in the 1980s–1990s by (among others) authors such as Edquist (1997), Freeman (1995), Lundvall (1992), and Nelson (1993), and the approach argues that innovation takes place as an interactive process among and between actors embedded in an institutional framework. Thus, the system of innovation approach distances itself from the dominating idea of the way in which innovation is facilitated, namely as a linear process at that time (Asheim, Moodysson, & Tödtling, 2011). This linear model of innovation asserts that innovation is initiated by basic research and that the process continues by applied research and development before it ends with production and diffusion (Godin, 2006). According to this model, the level of innovation can be raised by increasing the R&D costs and the model suggests that geographical variations in innovation can be understood from different amounts spent on R&D.

However, as stated above, the introduction of the SI approach separated from the linear model of innovation. Or, as described by Asheim and colleges, the introduction of the SI approach ‘represented a transition from a linear view on innovation to an interactive view’ (Asheim, Moodysson, & Tödtling, 2011, p 1134). The SI approach argues that innovation follows a non-linear process (Lundvall, 1992) more than it does a linear process, and that this non-linearity includes knowledge sharing activities amongst different types of actors, like firms, R&D organisations, entrepreneurs, and policy agents. Thus, the approach recognises that innovation is a diverse phenomenon that can also result from other forms of knowledge development than simply R&D. It

further stresses that the result of the interactivity is highly influenced by the institutional framework in which actors are embedded (Edquist, 1997, 2001). Following these arguments, the SI approach explains differences in innovation between nations as a consequence of differences in the national systems of innovation and not mainly from national differences in R&D investments (Lundvall, 1992; Nelson, 1993).

2.2.2. The regional innovation system approach

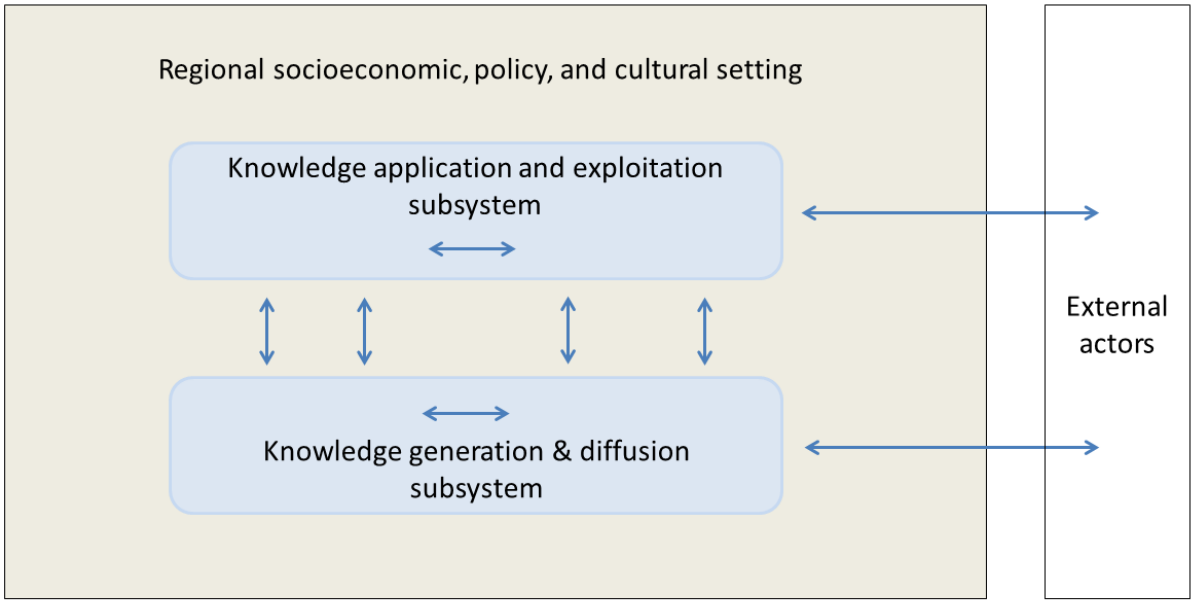
Inspired by the conception of the national innovation system, the regional innovation system (RIS) approach was introduced in the 1990s–2000s (Asheim & Coenen, 2006; Asheim & Gertler, 2005; Asheim & Isaksen, 2002; Cooke, 1992, 2001). The rationale behind the approach was the notion that the same mechanisms as argued at the national level also manifest at the sub-national level as well as the increasing interest in the importance of regional contexts and geographical proximity to tacit knowledge transfer. Several definitions of RIS has been suggested since its introduction, and a later suggestion defines a RIS as 'encompassing all regional economic, social and institutional factors that affect the innovativeness of firms' (Asheim, Lawton Smith, & Oughton, 2011. p.48).

By its focus on the way in which sub-national contexts shape innovation, the RIS approach joined a long tradition of related theoretical concepts that also approach sub-national industrial differences. The first known concept that dealt with regional industrial differences was introduced by Alfred Marshall (1842–1924), when he presented his research related to industrial districts (Marshall, 1890)[7], and since then several concepts have been introduced, such as the learning region approach (e.g., Asheim, 1996; Florida, 1995; Morgan, 2007), the concept of innovative milieus (e.g., Camagni, 1995), and cluster theory (e.g., Porter, 1998, 2000). Common to these theoretical approaches is an understanding that macro-level phenomena are deeply rooted in and dependent on the local milieu (Asheim, Grillitsch, & Trippl, 2016). Porter highlighted this dependency on the local, stating that 'the enduring competitive

[7] The work of Marshall was revitalised by Giacomo Becattini who several years later, researched patterns of industrial specialisation in Northern Italy (Becattini 1986, 1990).

advantages in a global economy lie increasingly in local things – knowledge, relationships, motivations – that distant rivals cannot match' (Porter, 1998, p. 78).

At its core, the regional innovation system approach argues that innovation should be seen as a result of interactive learning processes among and between actors within two regional subsystems; furthermore, this interactivity is embedded in an institutional framework (Tödtling & Trippl, 2005). The first subsystem of actors represents the regional business sphere. This sphere includes individual entrepreneurs and firms as well as their formal and informal organisations of clusters, networks, and industries. The second subsystem consists of the local generators and diffusers of new knowledge and skills, which include public and private R&D institutes, educational organisations, technology-mediating organisations, and more (op. cit.). Finally, the two sub-systems are embedded in institutions (Amin & Thrift, 1994),[8] which are recognised as a set of cultural–cognitive, normative, and regulative elements (Scott, 2008) that form the 'rules of the game' in the local society (North, 1990). Figure 2.1 provides an illustration of a RIS.



Source: Authors' own but inspired by Tödling and Trippl (2005, p. 1206)

Figure 2.1: Illustration of a Regional Innovation System

[8] Please note that Amin and Thrift (1994) did not distinguish between organisations and institutions but introduced institutional thickness as a term that included both organisations and institutions. This thesis does not follow this line of thinking but treats organisations and institutions as strongly linked but still separate entities.

2.2.2.1. The organisational dimension of RISs

With regard to the organisational dimension, the RIS approach distinguishes analytically between three types of regional innovation systems, namely thin RISs, thick and specialised RISs, and thick and diversified RISs (Isaksen & Trippl, 2016).

Following the description provided by Isaksen (2015) and Tödtling and Trippl (2005), 'organisationally thin RISs' describes regions that host a limited and SME-dominant portfolio of firms, no (or only a few) clusters, and no (or just a few) universities and R&D organisations. Further, as they have fewer organisations, such regions most often focus their educational system on developing low- or medium-level qualifications and place less emphasis on higher-level education, which demands a research-active local university. According to Karlsen (2013), thin RISs are not 'complete' RISs but should be understood as developing RISs. The argument is that the limited number of actors present in the region hampers the interactive learning activity and further that the lack of R&D organisations results in a low level of research-based knowledge, which is essential to more path-breaking innovations. However, regions evolve and develop, and thin regions can, therefore, transform into complete RISs over time (op. cit., p. 91).

Contrasting thin RISs, organisationally thick RISs host many actors in both subsystems (Isaksen & Trippl, 2016). Thick RISs, however, can take two alternative forms, either specialised or diversified. A thick and specialised RIS has many actors but a narrow industry base and a subsystem of knowledge creators and diffusers, which primarily aim to support the existing industries. Such industrial specialisation provides environments rich in Marshall–Arrow–Romer (MAR) externalities, which are described as favourable conditions due to industrial co-location (Neffke, Henning, Boschma, Lundquist, & Olander, 2011b). Such beneficial conditions can include a tailored and well-functioning support system, a highly specialised labour force, a high number of localised specialised suppliers and customer firms, and a milieu rich in intra-industry knowledge spillovers. Such advantages promote low transaction costs and cost-effectiveness. A thick and diversified RIS, on the other hand, hosts a variety of industries, a rich portfolio of R&D organisations, and a wide range of knowledge and innovation supporting organisations (Isaksen et al., 2016). Such environments are rich in Jacobs' externalities (Jacobs, 1969), which are described as favourable conditions due to a high level of industrial diversity (Neffke et al., 2011b). Such

conditions provide easy access to supplementary resources and generous regional knowledge spillovers from a variety of actors.

A regional innovation system is an open system. This openness implies that the actors within a RIS are actively connected to actors outside the regional system and thus that knowledge is actively sourced and shared beyond regional boundaries. This notion of RISs as open systems, however, poses challenges for empirical research regarding the identification of RIS boundaries. How can we determine the geography of a RIS, and where does the geographical border separate one RIS from another? The literature has provided no consensus regarding these questions, and empirical research has suggested a variety of sizes relevant to such RIS fencing. Karlsen pointed to the definition of thin RISs and argued that a 'RIS can be defined geographically by the location of one of the subsystems' (Karlsen, 2013, p. 91). The pragmatic way to identify and separate RISs, he further stated, is by the use of administrative units like counties or functional regions like labour market regions. Other researchers have delimited regional innovation systems differently, as they have studied RISs empirically on a broader geographical scale, for example, provinces (Trippl & Otto, 2009). An argument advocating a more finely graded geographical scale of RISs is that it is necessary to take into consideration the heterogeneity of larger geographies. This heterogeneity is also evident for innovation, as 'innovation is indeed often a highly localized phenomenon, dependent on place-specific factors and conditions' (Martin, 2010, p. 20). Such heterogeneity is demonstrated in article II of this thesis. The paper defines RISs as being located within the geographical boundaries of local administrative units (LAU1) and finds that there are significant differences to be identified between thick and thin RISs located in Agder, situated at the southern tip of Norway. This finely graded analysis of the Agder area corresponds well to complementary analysis that focuses on industrial development in the same geography. Examples are the studies by Isaksen and Trippl (2017a), who analysed new industrial development in the Grimstad–Arendal region, Isaksen (2015), who investigated how new industrial development has taken place within the organisationally thin region of Lister, and Isaksen (2016), who researched the emergence of a boat-building industry cluster in Arendal during the 1950s and 1960s.

Furthermore, it should be mentioned that thick and thin regions should be understood as relative terms. In article II, the region of Kristiansand is considered to be a thick region compared with the regions of Mandal or Setesdal, while, in paper III, the region

of Hamar is considered to be thin compared with Molde and Oslo. If one wishes to continue to move up the comparative scale, it could finally also be argued that Norway is a peripheral region of Europe and that Norway can be classified as consisting of fairly thin regions compared with metropolitan areas like Greater London or the Aire Urbaine de Paris. The point in scaling is, however, that regions are differently conditioned to promote innovation and that such differences can be identified and analysed by focusing on the organisational thickness and diversity as well as the institutional framework of the regions in focus.

Finally, because thick RISs are more dense and urbanised than thin RISs (Isaksen & Trippl, 2016), industry actors experience greater geographical proximity to suppliers and customers in thick RISs than they do in thin RISs. Aarstad, Kvitastein, and Jakobsen (2016, p. 847), emphasised that '..geographical proximity in densely populated regions means that enterprises can serve a market that is locally accessible. This reduces transportation costs and increases market size, which facilitates a high volume of sales revenues of products and services assembled at a relatively low cost, because of the economies of scale from serving numerous buyers. A large market and geographical proximity to other markets may also facilitate stability in demand …'. Following this argument of a large, stable, market in close proximity, one can expect that productivity and revenues are relatively high in thick regions compared with thin regions. Furthermore, it is reason to assume that entrepreneurs located in such favourable local conditions are more prone to achieve growth than their fellow entrepreneurs located in thinner RISs.

2.2.2.2. The institutional dimension of regional innovation systems

Institutions could be defined as a set of formal and informal rules and regulations that influence actors' decisions (North, 1990). As such, institutions are collective behavioural guidelines (Scott, 2008) that influence individual and organisational preferences and possessions: in short, institutions are 'the rules of the game in society' (North, 1990, p. 3). According to Scott (2008, p. 48), these behavioural guidelines could be understood as social structures composed of cultural–cognitive, normative, and regulative elements. Cultural–cognitive elements are recognised as constructed symbolic representations 'providing vital templates for framing individual perceptions

and decisions' (Scott, 2010, p. 7), while the normative element includes a softer and more political set of guidelines. Finally, the regulative elements of institutions are recognised as formalised, explicit expressions, like rules, incentives, or sanctions.

As they are embedded, and function as behavioural guidelines for regional actors, these cultural–cognitive, normative, and regulative elements have been practised over time and taken for granted. An institution that has proven to be favourable to the local community and developed into this stage of becoming taken for granted is labelled as being institutionalised. Thus, 'many ideas, schemas and prescriptions are proposed, but only a relatively small subset survive through repetitive interactions and the changing of actors to become institutionalized' (Scott, 2010, p. 10).

Institutions are important and positive phenomena. They are positive because they a) provide normative commitments, which include: 'the emergence of orderly, stable, social integrating patterns out of unstable, loosely organized, or narrowly technical activities' (Selznick, 1994, p. 232), b) confer legitimacy in the meaning of 'a generalized perception or assumption that the actions of an entity are desirable, proper or appropriate within some socially constructed system of norms, values, beliefs, and definitions' (Suchman, 1995, p. 574), and c) tend to increase the profitability of trade, as they reduce the level of opportunistic behaviour and lower the frequency of negotiations and the need for control (Coase, 1937; Williamson, 1979). However, institutions are not exclusively positive. Institutions favour stability and therefore also oppose change. As such, some regions can experience strong support for a stable state and the status quo along with equivalent resistance to revitalisation and renewal, which are important to survive in the long run (Martin, 2010). If not renewed, industries will eventually experience path exhaustion which results from a situation of declining innovation height (Isaksen & Trippl, 2016). Challenging the existing institutions, therefore, is important if one wishes to promote flexibility and change (Sotarauta & Pulkkinen, 2011).

A more recent contribution to the RIS literature was presented by Zukauskaite, Trippl, and Plechero (2017) and suggested classifying regions as either institutionally thick or institutionally thin,[9] where institutional thickness (thinness) refers to the presence, or absence, of supportive formal and informal institutions to promote knowledge

[9] The paper discussed the original concept introduced by Amin and Thrift (1994) and suggested an alternative definition of thick/thin institutions. The authors advocated a separation of organisations and institutions.

exchange and collective learning. Here formal institutions refer, for example, to laws, rules, and regulations, while informal ones include culture, norms, and values.

2.2.3. Entrepreneurial ecosystems and regional systems of entrepreneurship

As described above, the RIS approach was introduced to enhance our understanding of regional differences in innovation and economic growth (Asheim & Gertler, 2005). Even though the notion of RISs holds a dominating position within the EEG tradition and innovation studies, system perspectives to explain regional differences have also been introduced by other scholars and traditions. In entrepreneurship studies, two such system approaches are the entrepreneurial ecosystem (EE) approach (Spigel, 2017; Stam, 2015) and the regional system of entrepreneurship concept (Qian et al., 2012).

Entrepreneurial ecosystems are defined as ‘a set of interdependent actors and factors coordinated in such a way that they enable productive entrepreneurship within a particular territory’ (Stam & Spigel, 2016, p. 1). Thus, the EE approach concerns mainly high-growth start-ups and focuses on the role of context as either an enhancing or a restricting factor for entrepreneurship (Stam 2015). The EE approach is a ‘picking winners’ strategy that focusses mainly on how geographies can cultivate and strengthen cultural, social and material elements to foster productive entrepreneurship (Spigel & Harrison, 2017).

The EE approach coincides with the RIS concept by highlighting the importance of context to regional development. Even so, there are distinct differences between the two concepts. First, the EE approach maintains high growth entrepreneurs as the key drivers of economic development and the approach seeks to explain the heterogeneous geography of high growth entrepreneurs (Spigel & Harrison, 2017). The RIS approach, on the other hand, builds on the premise that innovation is the driver of regional economic development, and the approach seeks to explain the heterogeneous geography of innovation (Asheim et al., 2016). Thus, to the RIS approach, innovation is the driver of regional industrial growth, no matter who the exploiters of opportunities are.

This main difference in focus between EE and RIS are evident in several ways[10]. Two such differences are the role of knowledge creating organisations and the role of venture capital and finance institutions. When addressing the role of knowledge creators, for the RIS approach, the knowledge creating and diffusing organisations are vital as they contribute to infuse new knowledge for innovation, while for the EE approach these actors are less important. Spigel and Harrison (2017) suggests that this downgrade of the role of knowledge creators within the EE approach is due to the limited absorptive capacity of entrepreneurs and because of the specific difficulties startups encounter when trying to access localised resources. When addressing the role of venture capital and finance institutions, the role of these organisations is rather neglected by the RIS approach, while it is very important to the EE approach. This difference might be explained by the fact that large firms and corporations often hold solid economic muscles, while risk capital is a more critical resource for entrepreneurs to scale up their business.

Several critiques have been raised about the EE approach (Stam, 2015; Cooke, 2016). Stam argues, for example, that the concept appears to be rather tautological as 'entrepreneurial ecosystems are systems that produce successful entrepreneurs, and where there is a lot of successful entrepreneurship, there is apparently a good entrepreneurial ecosystem' (Stam, 2015. p. 4). He further argues that the approach has provided no clear reasoning of cause and effect, and finally, that 'it is not clear which level of analysis the approach is targeting' (op.cit. p. 5).

Another concept that focuses on determining how context affects entrepreneurship is the newly introduced 'regional system of entrepreneurship' approach (Qian et al., 2012). This system approach to entrepreneurship aims to 'bridge the innovation system approach and entrepreneurship studies' (Stam, 2015, p. 2), and, like in the RIS approach, a regional version stands beside a national version (Acs, Audretsch, Lehmann, & Licht, 2016; Acs, Autio, & Szerb, 2014). The regional system of entrepreneurship approach focuses on the role of entrepreneurs as drivers of regional economic development, and the concept is defined as 'those economic, social, institutional and all other important factors that interactively influence the creation, discovery and exploitation of entrepreneurial opportunities' (Qian et al., 2012, pp. 3–4). The approach researches the regional factors that may influence such activity and

[10] Further differences between EE and RIS theory are described by Spigel and Harrison (2017).

identifies the absorptive capacity of regions to exploit opportunities from entrepreneurial knowledge spillovers as one such factor. The concept of regional systems of entrepreneurship argues that the absorptive capacity to exploit entrepreneurial knowledge spillovers can be measured as human capital and that regions, therefore, need to strengthen the general level of regional human capital to increase the regional level of entrepreneurship (Qian et al., 2012).

2.2.4. The systemic approach of this thesis

This thesis adopts the RIS approach. Even so, it agrees with several shortcomings addressed by the new literature on regional systems of entrepreneurship and the entrepreneurial ecosystem approach. Two such shortcomings are the understudied role of individual entrepreneurs and their traits, personalities, and behaviour in innovation processes (Qian et al., 2012) and the understudied role of new entrepreneurial firms in regional industrial development (Sternberg & Muller, 2005).

However, despite agreeing with the shortcomings of the RIS approach, this thesis argues in line with the RIS concept and maintains innovation as the decisive factor that drives regional industrial development (Asheim et al., 2016). As so, it argues that innovation is a varied phenomenon and that DUI innovation modes are equally important to regional industrial path development as the STI alternative that is more likely to form high growth entrepreneurship (Cook, 2016). In line with this, it further holds that the exploitation of new or improved ideas is carried out within incumbent firms as well as in new firm formations and other types of organisations, like universities, policy support organisations, and public administrations. Thus, all types of actors have important roles to play in enhancing regional industrial development, including, but not exclusively, high-growth entrepreneurs. Such actors, the thesis argues, include also system-level entrepreneurs whose aim is not to gain economic profit but to create and develop the social structure important for innovation. Thus, the thesis maintains that innovation is inherently a social phenomenon (Fagerberg, 2005) and that it is ’fundamentally a learning procedure’ which involves interactivity between actors in networks (Cooke, 2016, p. 4).

Even if this thesis does not adhere to the entrepreneurial ecosystem or the regional system of entrepreneurship approach, it still recognises entrepreneurs as significant contributors to regional economic growth. However, when addressing entrepreneurs, it argues that the roles of firm-entrepreneurs are multifaceted and that their contribution to regional industrial development is not determined exclusively by their ability to achieve high growth. Most firm-entrepreneurs are not radical innovative and many new firms are proprietorships that do not strive towards expansion. Even if they are not high growth oriented, this thesis acknowledges their importance as contributors to regional industrial development. Further, the thesis argues that the RIS approach has neglected more entrepreneurial activity than evidence from firm-entrepreneurs. It introduces the notion of system-level entrepreneurs and researches the role of this non-profit seeking entrepreneur in processes of new regional industrial path development.

To sum up, the thesis adheres to the RIS approach and argues, in line with the innovation study literature, that innovation is the driver of regional industrial change. Further, and following the EEG literature, it also holds that, without innovation, dynamic industrial developments are impossible in the long run (Martin, 2010).

2.2.5. Knowledge sharing in various regional settings

In the previous chapter, I argued that knowledge is the key resource for innovation, that it sources differently, and that it comes in different forms and involves different proximities. In this chapter, I have presented the RIS approach, which highlights that regions are differently conditioned to stimulate innovative activity due to the variety of both their institutional conditions and organisational thickness and diversity. When combined, the literature presented has offered a more detailed analysis of the way in which regions vary in their knowledge sourcing activities and innovation capabilities. In the following, I discuss in more detail the variance in knowledge sourcing and innovation activities that are analytically expected in various regional settings.

Organisationally thin RISs are characterised by a relatively low number of actors in both sub-systems (Isaksen, 2015). The consequence of such organisational thinness is that these regions are also low in regional knowledge creation from R&D; thus,

regional firms generally hold a low level of absorptive capacity (Cohen & Levinthal, 1990) for analytical knowledge. From this, it follows that firms that are situated in thin RISs are mostly dominated by synthetic or symbolic knowledge which is characterised by a strong tacit component typically favouring a DUI mode of innovation that generates incremental product innovations or process innovations in existing firms (Isaksen, 2015; Jensen et al., 2007). The literature has most often argued that organisationally thin RISs can be found in peripheral areas (Isaksen, 2015). A classical suggestion following this line of argument is that innovation in thin regions relies heavily on intra-regional knowledge sharing activities, which favour learning by engaging in close interactions. This, however, raises an apparent dilemma. As organisationally thin regions are low in actors, there will be few regional alternative knowledge sharing partners. This issue was also highlighted by Isaksen (2015), who argued that there is (typically) little local knowledge exchange in thin RISs. A central question then concerns how thin RISs can overcome this obstacle of being organisationally thin. Some alternatives have been suggested by the literature. Building on the temporary proximity argument, thin regions can partly overcome this difficulty by activating impermanent solutions to increase their spatial proximity. Maskell, Bathelt, and Malmberg (2006) labelled such temporary professional gatherings as temporary clusters, and they argued that participation in such temporary clusters can increase the success rate of firms located outside industry agglomerations. Their main argument was that such temporary solutions can 'display some of the knowledge creating mechanisms found in permanent clusters, albeit in a short-lived and intensified form' (Maskell et al., 2006, p. 13). Isaksen (2015) pointed in another direction and highlighted the importance of external investments too thin regions. Such investments can include the establishment of new firms from outside or the inflow of external knowledge and technology following from both private initiatives and state institutions. Like article II in this thesis, Isaksen researches Lister as a thin region. By examining this region empirically, he found that the Lister region has gained substantially from external investments in the form of industry transplantation of three process firms. Such transplantations and investments support knowledge importation from outside the region, and these new firms also contribute to accessing the new inter-regional knowledge linkages to be explored. The most recent contribution focusing on the complex geography of innovation and knowledge sourcing activities was provided by Isaksen and Trippl (2017b). The article structured the discussion within a framework consisting of RIS types (thin, thick and specialised, and thick and diversified) and innovation modes (STI and DUI) and discussed the key knowledge

linkages and the degree to which local vs non-local knowledge matters for innovation activities. The article highlighted the importance of non-local knowledge linkages for firms situated in thin RISs. Such inter-regional linkages, the authors argued, are important regardless of the dominating mode of innovation. For DUI firms, the article highlighted innovation projects at all scales as the most vital knowledge link, while STI firms were suggested to be even more dependent on the non-regional scale. This is mainly because STI firms are closely linked to R&D milieus, which are most often not locally available in thin regions. Thus, the article suggested that important knowledge links for STI firms located in thin regions are national and international innovation projects, research publication channels, Internet searching and monitoring, and knowledge embodied in equipment and other imported products and services.

Organisationally thick and specialised RISs are recognised as being rich in actors but at the same time limited in the number of locally represented industries (Isaksen & Trippl, 2016). Such industry specialisation has most often been formed and reinforced through history, and thick and specialised RISs, therefore, benefit from a well-adapted knowledge and support network. Thick and specialised RISs are often found in old industrial areas (Isaksen & Trippl, 2016; Tödtling & Trippl, 2005), which are recognised by their incremental innovation in mature industries. As argued previously in this chapter, such geographies are rich in MAR externalities, which benefit local firms due to low transaction costs and a high critical mass of competent workers. However, such specialisation is also a potential danger to the region, as local actors most often lack complementary knowledge. Thus, knowledge linkages to all geographical scales are important. Isaksen and Trippl (2017b) argued that both STI firms and DUI firms located in such areas typically source knowledge from R&D projects, while STI firms typically also rely on labour mobility (both locally and beyond) as an important knowledge source.

Finally, the diversified version of thick RISs is characterised by many diverse firms and knowledge creating and support organisations in a wide range of industries and sectors (Isaksen & Trippl, 2016). Due to this diversity, such regions present low barriers to regional unrelated knowledge sharing activities and provide environments that encourage new ideas and innovation. Thick and diversified RISs are typically found in metropolitan areas. When analysing important knowledge links in this type of RIS, Isaksen and Trippl (2017b) found that STI firms acquire new knowledge mainly through spillovers and regional labour mobility, while DUI firms

tend to acquire new knowledge through regional labour mobility and project-based temporary networks. However, not all metropolitan areas are well-functioning hubs for innovation. Some thick and diversified RISs are more fragmented, with less knowledge sharing (Tödtling & Trippl, 2005). Such fragmented, diversified regions should increase their focus on strengthening the knowledge links within their regional boundaries (op. cit.).

To sum up, contemporary research has argued that the geographical dimension of knowledge sharing activities and innovation varies among firms in relation to their knowledge base or, as stated by Isaksen and Tripp (2017b), between firms and industries that rely on either an STI or a DUI mode of innovation. The literature has further suggested that the importance of inter-regional knowledge sources to innovation increases as the RIS's thickness and diversity decrease. Thus, out-of-the-region linkages are particularly important to thick and specialised and to thin RISs and less important to thick and diversified RISs. While thick and specialised RISs depend on non-local knowledge sources to secure diversity, thin regions are forced to source knowledge actively outside the region due to the low number of local alternatives. Finally, contemporary research has pointed towards several knowledge sourcing mechanisms and concluded that such sources hold different sensibilities to space. The literature has argued that mobility and knowledge spillovers are most sensitive to geography, while monitoring, though, for example, the Internet or publications, is the least geographically concerned.

2.2.6. Remaining questions

Even though the RIS approach has gained wide acceptance within the research community of economic geography, two critical issues have been emphasised specifically. The first issue relates to the fact that RISs have most often been treated as a static phenomenon. The literature has tended to address regions as either organisationally thick or organisationally thin and (if identified as thick) as either organisationally specialised or organisationally diverse. Only exceptionally have cases been presented that display regions as dynamic entities that develop and change in both organisational thickness and organisational diversity and their institutional framework. One such exception was presented by Kostiainen and Sotarauta (2003), in

which they analysed the development of Tampere in Finland. The authors described and analysed the way in which Tampere first developed from a small village into a leading industrial town and then, from this state of being a leading industrial town, developed further into becomming one of Finland`s leading cities of the knowledge economy. The authors argued that this transformation was possible due to its openness and its interregional knowledge exchange, including both national and global partners. Despite still lacking practical examples in the literature, contemporary research has increased its focus on the evolution of RISs from an analytical point of view. One line in this stream of research has addressed regional resilience from the perspective of path dependency. This stream of research has argued that regional industries develop along historically determined trajectories and that regions have to challenge these historical boundaries to promote a dynamic RIS evolution (Isaksen & Jakobsen, 2017; Isaksen & Trippl, 2016; Martin, 2010).

The second main critique of the RIS approach is that it is overly focused on systemic factors and therefore pays less attention to the actors emerging within the system (Qian et al., 2012; Sternberg & Muller, 2005; Uyarra, 2010). This critique argues that, even though RISs are a meso-level phenomenon, and even though the meso-level effects differ from the sum of the individual components (Sayer, 2000), such phenomena are still rooted in micro-level actions. As such, gaining a better understanding of how the actors and the system mutually affect each other becomes important in explaining and understanding change processes within RISs and the way in which RISs transform over time.

2.2.7. How this thesis addresses the remaining questions identified

This thesis researches these identified shortcomings. Articles I, II, and III investigate the first identified shortcoming. Article I discusses theoretically how entrepreneurial growth intentions and innovativeness expect to influence regional industrial path development further. The paper argues that the most innovative and ambitious entrepreneurs are the ones who are expected to cause the most radical changes to the regional innovation system, while the least innovative and ambitious entrepreneurs are expected to contribute more to industrial stability and minor changes. Article II continues this line of thinking and researches the geography of innovativeness and

growth ambitions among entrepreneurs. The article finds that thick regions host the most innovative entrepreneurs and thus that thick regions promote the best environments for cultivating path-breaking ideas. Paper III studies the evolution of regions from a regional entrepreneurial discovery processes approach. The article reports that regions hold different prerequisites for supporting regional change processes and further that the expected outcome of change processes will affect further development differently.

All four articles research the second identified shortcoming. Article I focuses on entrepreneurs and their possible contribution to further industrial growth measured by their ambitions and the innovativeness of their ideas, while article II focuses on the geography of the same variables. Article II addresses the relationship between actors and system, as it demonstrates that thick regions are more favourable to innovative entrepreneurs than thin regions. Article III investigates the relationship between actors and systems that takes place within a process of entrepreneurial discovery. The article identifies entrepreneurs at two levels (the firm level and system level) and studies how these two types of entrepreneurs contribute differently to the process of system change in new regional industrial path development. Finally, paper IV addresses the dynamics between actors and system when researching combinatorial knowledge sourcing activities within an emerging industry in Bergen. The paper investigates knowledge sourcing by mobility, collaboration, and monitoring and finds that knowledge sourcing mechanisms, as well as knowledge bases, are differently sensitive to space. It further finds that the region is the overall most important geography to knowledge sourcing mechanisms. Thus, the article confirms the importance of regional settings to new regional industrial path development.

2.3. Regional entrepreneurial discoveries

2.3.1. Theoretical roots

The entrepreneurial discovery process is a concept that is rooted in the Austrian school of economics (Kirzner, 1997). The phrase 'Austrian school' refers to the economic tradition formed by Austrian economists, who stood out from the mainstream economic reasoning by questioning, and rejecting, some of the core concepts of the neoclassical understanding of economics. Some of the main contributors within the Austrian school of economics are Carl Menger (1840–1821), Friedrich von Wieser (1851–1926), Ludwig von Mises (1881–1973), Friedrich von Hayek (1899–1992) and the American economist Israel Kirzner (born in 1930).

In his preface to the abridgement of *Human action* by Ludwig von Mises, Gèrard Drèan (2014) highlighted the following themes when describing how the Austrian school of economics stands apart from mainstream neoclassical economics: 'Actually, the Austrian school differs fundamentally from neoclassical "mainstream" economics by its very conception of the discipline and of the methods appropriate to its substance. For instance, it rejects the model of the rational and omniscient homo economicus, it studies the processes of change and not equilibrium, rejects the separation between macroeconomics and microeconomics, and considers the use of mathematical reasoning as not only inappropriate but harmful' (Drèan, 2014, p. 5). Thus, the Austrian school of economics argued against the dominating economic approach by rejecting the very core of its theory. Austrian economists summed up their critique by stating that neoclassical economic theory is unable to explain economic change and development. The core argument of the critique was that a world of perfect rationality and a stable state would be unable to produce new opportunities, so there would be no opportunities to be exploited. Ludwig von Mises addressed the impossibility of an everlasting stable-state situation as follows: 'The imaginary construction of an evenly rotating economy has no counterpart in reality. There can never emerge a state of affairs in which the sum of the prices of the complementary factors of production, due allowance being made for time preference, equals the prices of the products and no further changes are to be expected' (Drèan, 2014, p. 77).

2.3.2. Entrepreneurial discovery as a spontaneous process

In essence, the Austrian school argues that markets exist because opportunities exist and further that entrepreneurs are key actors in these market areas because they are the ones exploiting the opportunities. This Austrian discovery approach towards the role of entrepreneurs is, however, in sharp contrast, not only to the neo-classical view but also to the German tradition represented by Joseph Schumpeter. These three contrasting views of the dynamic role of entrepreneurs are described by Wennekers and Thuric in the following way: 'The (neo-) classicals stress the role of the entrepreneur in leading markets to equilibrium through their entrepreneurial activities. The Austrians concentrate on the abilities of the entrepreneur to perceive profit opportunities, usually after some exogenous shock. The "Austrian" entrepreneur combines resources to fulfil currently unsatisfied needs or to improve market inefficiencies or deficiencies. In the German or Schumpeterian tradition economists concentrate on the entrepreneur as a creator of instability and creative destruction' (Wennekers & Thuric 1999, p. 31). In the following, a very short presentation of the Schumpeterian (German) and the Kirznerian (Austrian) view of the role of entrepreneurs is provided.

The core of the Schumpeterian theory of economic development is that economic progress results from disturbance to the state of equilibrium. If economic growth and prosperity are to take place, Schumpeter argued, a 'spontaneous and discontinuous change in the channels of the flow, disturbance of equilibrium, which forever alters and displaces the equilibrium state previously existing, is needed' (Schumpeter, 1934, p. 64). He further argued that change processes like this result from new combinations of existing resources, and defined development as a process resulting from one of the following 5 alternatives: (1) the introduction of a new good; (2) the introduction of a new method of production; (3) the opening of a new market; (4) the conquest of a new source of supply of raw materials or half-manufactured goods; or (5) the carrying out of the new organisation of any industry (Schumpeter,1934, p. 66). To the young[11] Schumpeter, the entrepreneur was the driving force of economic development. He defined entrepreneurs as the individuals who carried out these new combinations of resources and saw entrepreneurs as change agents of the economy.

[11] While the young Schumpeter (Mark I) argued that innovation and change come from entrepreneurs, the more mature Schumpeter (Mark II) asserted that big companies are the drivers of change, as they possess the resources necessary to invest in R&D.

These change agents, he argued, introduce radical new solutions to the marketplace; by doing so, they force the existing actors to change and improve if they are to maintain their previous position. Schumpeter later labelled this process of radical change and adaption as the process of creative destruction (Schumpeter, 1942 [2013]).

Israel Kirzner, on the other hand, distanced himself from Schumpeter in his rather narrow definition of entrepreneurs as radical innovators (Kirzner, 1973). According to Kirzner, entrepreneurs can be understood as actors who exploit failures of coordination and therefore represent a stabilising force in the economy rather than a disruptive one. According to Kirzner, entrepreneurs constantly monitor the market for possibilities to gain entrepreneurial profit. Kirzner argued that entrepreneurial profit is the main driver of entrepreneurial activity and further that entrepreneurial profit results from imperfect knowledge of market conditions. He defined a pure entrepreneur as a person who 'proceeds by his alertness to discover and exploit situations in which he is able to sell for high prices that which he can buy for low prices' (Kirzner, 1973, p. 48). He further defined pure entrepreneurial profit as 'the difference between the two sets of prices' (op. cit.). Kirzner explained the difference in the view of the entrepreneur between himself and Schumpeter as follows: 'For Schumpeter the entrepreneur is the disruptive, disequilibrating force that dislodges the market from the somnolence of equilibrium; for us the entrepreneur is the equilibrating force whose activity responds to the existing tensions and provides those corrections for which the unexploited opportunities have been crying out' (Kirzner, 1973, p. 127).

Despite several attempts to develop entrepreneurship into a coherent research paradigm, the discipline still includes different views of what entrepreneurship is and how entrepreneurial opportunities are formed. In their AMR[12] decade awarded paper, 'The promise of entrepreneurship as a field of research', Shane and Venkataraman (2000) defined the field of entrepreneurship as 'the scholarly examination of how, by whom, and with what effects opportunities to create future goods and services are discovered, evaluated, and exploited … the field involves the study of the sources of opportunity, the processes of discovery and evaluation, and the exploitation of opportunities and the sets of individuals who discover, evaluate and exploit them' (p. 218). This definition gained substantial support in later research, but there is still no consensus on the definition (Shane, 2012). The most supported alternative

[12] *Academy of Management Review*

definition, according to Shane (2012, p. 12), describes entrepreneurship strictly in terms of the formation of firms or organisations.

According to Sarasvathy and colleges, an entrepreneurial opportunity can be understood as consisting of ‘ a set of ideas, beliefs and actions that enable the creation of future goods and services in the absence of current markets for them’ (Sarasvathy et al., 2003, p. 142), and, according to the same authors, three alternative routes to entrepreneurial opportunities can be identified. These routes were described as ‘opportunity recognition’, ‘opportunity discovery’, and ‘opportunity creation’ (op.cit., p. 145). The authors referred to the mechanism of supply and demand when they defined the difference between the three routes, and they argued that opportunity recognition occurs when both the supply side and the demand side are known. Thus, opportunity recognition refers to the process of matching up an existing demand with an existing supply, as in arbitrage or franchises. Further, opportunity discovery refers to market situations in which either the supply side or the demand side is non-existent. In such situations, the missing side has to be ‘discovered’ before a match between the supply and the demand can be introduced. The authors referred to cures for diseases and applications for new technologies as examples of opportunity discovery. Finally, the authors referred to opportunity creation as the final alternative, which is best described by preconditions in which neither a supply nor a demand exists. In such circumstances, both have to be created.

As described above, there are still fundamentally different perspectives on the phenomenon of entrepreneurship[13] and on the question of whether opportunities are created, discovered, or recognised (e.g., Alvarez & Barney, 2007; Klein, 2008; McMullen, Plummer, & Acs, 2007). However, even distinct, all three alternatives are considered as spontaneous processes as opposed to regionally managed and planned processes. Thus, the exploitation of opportunities initiates from individual and firm initiatives. A systematic review of the opportunity literature was presented by George, Parida, Lahti, and Wincent (2016), who concluded that the literature has identified six prominent factors that can contribute to shedding light on why some people recognise, discover or create opportunities while others dont. These factors are ‘prior knowledge, social capital, cognition, environmental conditions, entrepreneurial alertness, and systematic search’ (op. cit., p. 328).

[13] See Shane (2012, p. 12) for a short summary of the most prominent definitions.

2.3.3. Entrepreneurial discovery as a planned process

In recent years, the concept of entrepreneurial discovery has gained increased attention amongst practitioners as well as researchers. This enhanced attention is mainly due to the introduction of the Research and Innovation Strategies for Smart Specialisation (RIS3), launched by the EU. RIS3 is a policy concept that aims to increase the competitiveness of the EU regions through a process of regional diversification. The rationale behind the concept is, for the EU, an overall need to coordinate funding as well as innovation initiatives, and for making the union more competitive. The RIS3 policy concept encourages regions to diversify to strengthen their competitiveness. Such diversification is important as 'no region can be competitive in all industries, but most regions can compete in one or in a restricted set of industries' (Johnsen, Rypestøl & Schulze-Krogh, 2018, p 76). Today all member regions need to have a RIS3 to qualify for funding from the European Regional Development Fund.

A central methodology that comes in the RIS3 "toolbox" is the entrepreneurial discovery process (EDP). An EDP follows two phases, those of initiation and following structural changes. Thus, an EDP is 'the essential phase, the decisive link that allows the system to reorient and renew itself' (Foray, 2015, p. 24).

As described in the previous section, the recognition, discovery and creation of opportunities most often occur as a spontaneous process. Such spontaneous EDPs are 'triggered by an entrepreneurial vision, the discovery of a new domain and the integration of different types of knowledge to turn this discovery into reality' (Foray, 2015, p. 20). However, if EDPs do not emerge spontaneously, the RIS3 policy concept suggests that such processes should be stimulated by policy instruments aimed at facilitating this dynamism. This type of EDPs implies that stakeholders get together and actively search for new opportunities, and the smart specialisation strategy suggests that such planned and managed processes of entrepreneurial discovery should include a wide range of stakeholders to increase its chance of success (Rodriguez-Pose & Wilkie, 2015). In fact, the question of who should be involved in planned EDPs is, according to Foray, Goddard, and Beldarrain (2012), best answered by including 'whoever is best placed to discover the domains of R&D and innovation in which a region is likely to excel given its existing capabilities and productive assets' (p. 12). According to the same authors, analysing the regional context and potential for

innovation should cover three main dimensions (p. 18). First, regional assets should be analysed; second, intra-regional linkages should be identified; and third, the dynamics of the entrepreneurial environment should be evaluated. Regarding the entrepreneurial environment, the authors specifically highlight the importance of 'assessing whether it is lively and can generate a significant flow of experiments, innovation ideas, or entrepreneurial discoveries, or it is poor in experiments and entrepreneurial proposals and hence such activities should be specifically supported' (p. 20).

From the above we conclude that entrepreneurial discoveries can also follow from a forced, planned and managed process. Such processes aim to reveille promising areas of industrial diversification and the intention is to strengthen regional industrial competitiveness. Such planned processes should include a variety of different stakeholders including both profit-seeking and non-profit seeking actors, and the search for potential new domains should include regional assets, intra-regional linkages and regional entrepreneurial dynamism. Finally, we also conclude that planned EDPs can benefit from all types of entrepreneurial activities, including recognition, discovery and creation.

2.3.4. The process following a successful discovery

Despite its origin as a spontaneous or a planned process, if attractive, an entrepreneurial discovery will magnetise new firms and other actors and thereby cause a notable change in the RIS (Kirzner, 1973; Foray, 2014; Schumpeter, 1934). Schumpeter referred to this phenomenon as the swarming effect (Schumpeter, 1942 [2013]). Such an effect occurs because actors who want to take part in the success are drawn into the new domain. As such, a new and promising discovery will expand the industry structure given that similar or complementary businesses 'are induced to shift investments away from older domains with less growth potential to the new one' (Foray, 2014, p. 497). However, changes from successful initiations will not only occur within the domain of firms and industries. Notable structural changes are also expected to evolve within the domain of knowledge generation and diffusion and within the institutional framework (Rodríguez-Pose & Wilkie, 2015).

A central element in the process of development of EDPs is knowledge spillovers (Foray, 2015). At first, knowledge spillovers are generated mainly from the initiating idea which stimulates the entry and agglomeration of additional firms and innovation in existing ones. However, as the industry emerges increased network activity and innovation follows, and such increased activity adds to the generation of knowledge and opportunities spilt over. From an entrepreneurship perspective, entrepreneurial knowledge spillovers can be understood as 'knowledge created by incumbent firms and research organizations, which is underexploited and not fully commercialized for purposes of economic gain' (Acs, Audretsch, & Lehmann, 2013, p. 758). Such entrepreneurial knowledge spillovers represent new opportunities for entrepreneurs. These new opportunities are, however, somewhat special, as new knowledge can be exploited (at least to some extent) without the entrepreneur having to bear the full cost of its creation. Entrepreneurs who exploit knowledge spillovers are referred to as high-impact entrepreneurs (Acs, 2010), and the theory of entrepreneurship that researches this phenomenon is the knowledge spillover theory of entrepreneurship approach (KSTE) (Acs et al., 2013; Acs, Braunerhjelm, Audretsch, & Carlsson, 2009; Ghio, Guerini, Lehmann, & Rossi-Lamastra, 2015). In essence, the KSTE literature has argued that 'entrepreneurial behaviour is a response to profitable opportunities from knowledge spillovers' and further that 'the reason people start entrepreneurial firms is that they have access to knowledge spillovers' (Acs et al., 2013, p. 759). The KSTE literature argues that the theory offer an alternative to the creation–discovery dichotomy, as it focuses more on the heterogeneity of contexts than on the heterogeneity of individual entrepreneurs.

Regarding the type of knowledge interactions that are relevant to innovation (Tödtling et al., 2006), the KSTE literature has argued in favour of the static alternative more than the dynamic, interactive learning alternative. It is important to highlight, however, what has been addressed earlier, namely that a certain level of cognitive proximity has to be present if the knowledge spilt over (or shared by other channels) is to be relevant (Boschma, 2005). If the actor sourcing knowledge (actively or passively) does not have the absorptive capacity (Cohen & Levinthal, 1990) to understand and utilise it, such knowledge (either spilt over or shared differently) is of no use and can even be negative (Nooteboom et al., 2007).

2.3.5. Remaining questions

One area of research that has not been fully explored is the geography of entrepreneurial discovery processes. This thesis finds reason to assume that entrepreneurial discovery processes vary among regions. This assumption follows the fact that there are several versions of RISs (e.g., Isaksen & Trippl, 2016) and further that EDPs unfold within these various systems. Thus, one can assume that the regional context will affect the nature of entrepreneurial discovery processes differently and that these various entrepreneurial discoveries, in turn, will promote further industrial development differently.

Moreover, another shortcoming worth mentioning stems from the fact that EDPs involve multiple entrepreneurial agents (e.g., Rodríguez-Pose & Wilkie, 2015). Such agents include both profit-seeking and non-profit-seeking actors (e.g., Foray et al., 2012). As shown previously, the literature has provided substantial research on how firms interact in processes of innovation. However, less emphasis has been placed on the importance of non-profit-seeking, facilitating actors and the way in which firms interact and source knowledge and guidance from these types of agents for innovation.

2.3.6. How this thesis addresses the remaining questions identified

This thesis addresses these identified shortcomings in article III. The article researches conceptually how spontaneous entrepreneurial discovery processes are formed and shaped by their hosting RIS and how EDPs, in turn, are expected to influence differently the further development of the industry in which it takes place. The article further investigates the role of various forms of entrepreneurs and places its main focus on the role of firm-level entrepreneurs and system-level entrepreneurs in EDPs.

2.4. Path dependent regional industrial development

2.4.1. Theoretical roots

Path dependency theory is central to the discipline of evolutionary economic geography (Boschma & Frenken, 2006, 2012; Isaksen & Trippl, 2014; Martin and Sunley, 2006; Martin 2010). The theory originates from the work of Paul David and Bryan Arthur in the 1980s (e.g. Arthur, 1989; David, 1985), the pioneering research of whom demonstrated that technology (as well as industrial location) tends to follow certain trajectories in its development[14]. This first model of path dependency builds on three commonalities. These commonalities are firstly that path dependency processes tend to originate from non-controllable incidents, secondly that path dependence occurs if the process following this initial accidental event develops increasing return effects, and finally that, once a path dependency process occurs, the line of further development is 'locked in' and can only be unlocked by an external shock.

2.4.2. Contemporary path dependency theory

Following the pioneering work of David and Arthur, the notion of path dependence gained substantial attention in the field of evolutionary economic geography (EEG). From an EEG standpoint, contemporary path dependency theory refers to the development of economic landscapes as accumulated processes whereby economic actors tend to follow certain pathways that are restricted and formed by history (Martin, 2010; Martin & Sunley, 2006). Thus, the canonical model of path dependency theory has gradually been modified and extended in relation to all three commonalities originally claimed.

Firstly, with regard to the phase of origin, contemporary EEG advocates an evolutionary approach to the initiation of such processes rather than coincidences, chance, or random events (Boschma & Frenken, 2006; Isaksen, 2015; Isaksen & Trippl, 2016; Martin, 2010; Tödtling & Trippl, 2013). Secondly, addressing the stage at which path dependency develops, the research community has widened the range of possible increasing-returns effects, which can eventually lead to path dependency.

[14] See Martin (2010) for a review of their substantial work and significance

Such examples include knowledge spillovers and a local pool of specialised labour. Finally, concerning the stage of lock-in, EEG suggests that unlocking by shocks is not the only way to change the course of existing pathways (Martin, 2010). Contemporary research within the field has argued that existing pathways can be unlocked by various mechanisms of renewal and that new pathways can be created intentionally (e.g. Grillitsch & Trippl, 2016; Isaksen et al., 2016; Martin, 2010; Martin & Sunley, 2006; Tödtling & Trippl, 2013).

2.4.3. Path dependent regional industrial development

According to the path dependency concept, the way in which regional industries develop is anchored and influenced by history. An industry consists of firms that produce 'products that are close substitutes for each other' (Porter, 1980, p. 5), and the historical development of a regional industrial pathway can be identified from the choices and decisions made by those related firms in the past. As presented above, contemporary research has argued that the future development of existing paths can take several directions, and such alternative path developments are presented in the following as well as in Table 2.1.

Industrial path extension is recognised from incremental firm innovation 'along prevailing technological paths, which in situations of growth can lead to continuity or more of the same in a regional economy' (Isaksen, 2015, p. 3). Thus, regional path extension involves innovation to maintain competitive strength and includes activities that will extend the industrial lifecycle. However, industrial path extension will, due to its 'more of the same' strategy, ultimately lead to a gradual decrease in innovation height and the industry will eventually confront a phase of minimal competitiveness. Industrial path extension can, therefore, ultimately, face destruction as its final outcome (op.cit.). Due to this lack of dynamism, industrial path extension is not included as a category in new path development (Isaksen, 2015; Isaksen & Jakobsen, 2016). However, this field of research is evolving and the conceptualizing of various paths is still not concluded.

Industry path upgrading is an intra-path development that represents a major industry change resulting from a shift of network position within global value chains. An example of such shifts can be found within the Styrian metal cluster (Tödtling &

Trippl, 2004). This metal cluster in the Austrian region of Styria had created significant regional growth for an extended period until the industry experienced severe crises in the 1970s and 1980s. Since then, the metal industry in Styria gradually transformed into what can be classified as an 'old industrialised area' (op. cit., p. 1179). However, during the 1990s and early 2000s, successful restructuring was carried out based on a shift of value chain position from mass production to more specialised production.

Table 2.1: Typologies of path development

Forms of path development	Mechanisms
Path extension	Continuation of an existing industrial path based on incremental innovation in existing industries along well-established technological trajectories
Path upgrading	Major change of a regional industrial path related to enhancement of position within global production networks; moving up the value chain based on upgrading of skills and production capabilities
Path modernisation	Major change of an industrial path into a new direction based on new technologies or organisational innovation
Path branching	Development of a new industry based on competencies and knowledge of existing related industries (related variety)
Path importation	Setting up of an established industry that is new to the region (e.g. through foreign firms)
Path creation	Emergence and growth of entirely new industries based on radically new technologies and scientific discoveries or as outcome of search processes for new business models, user-driven innovation, and social innovation

Source: Grillitsch and Trippl (2016, p. 10)

The second alternative of industrial intra-path change is *industry path modernisation*. The mechanism that forms path modernisation includes a major change of path direction resulting from the implementation of new technologies or organisational

innovations. An example of the path modernisation category is the restructuring of the Eyde cluster of process firms in the Agder region[15]. From being among the main polluters, the regional cluster firms transformed into more sustainable organisations in their production processes and are continuing their restructuring towards becoming a zero-emission industry by 2050. Another example of the same is the food industry in Scania[16] located in the southern part of Sweden that experienced a process of path modernisation from the injection of new scientific knowledge (Grillitsch and Trippl, 2016).

Moving from the restructuring of existing pathways to the creation of new ones, Table 2.1 identifies three possible alternatives for the creation of new industrial paths. The first of the three is *path branching*, which describes a process of development in which existing industries evolve into new but related ones, based on intense knowledge sourcing and localised learning mechanisms between related firms. Thus, path branching most often involves innovation processes that include the sharing of related knowledge. The literature has provided several examples of such processes. Tödling and Trippl (2013) provided an example of branching processes when introducing the case of the old mining and steel complex within the Ruhr area. According to the authors, this cluster of old mining and steel firms underwent a process of branching into an environment protection industry. The new industry was created from a branching process in which existing knowledge was transferred to new markets (op. cit., p. 6).

The second alternative in the creation of new regional pathways *is path importation*. The typology of path importation represents the form of new path development that results from a transplantation process in which an industry is planted within a region in which it has not located before. One example of such industrial importation was provided by Tödling and Trippl (2013) when they described the importation of the automotive industry in Styria, Austria. According to Isaksen et al. (2016, p. 5), this importation was a result of several factors, such as 'the interplay of incoming foreign-owned companies, diversification strategies of incumbent firms (e.g. in the metal

[15] An article addressing this transmission is in submission at the Norwegian Journal of Geography. Kyllingstad & Rypestøl (in review), Towards a More Sustainable Process Industry: A Single case study of restructuring within the Eyde process industry cluster. *Norwegian Journal of Geography*. A copy of the article is available by request.

[16] See Zukauskaite & Moodysson (2016) for an analyse of this process of industrial development

industry) and the existence of traditional roots and competencies in the automotive sector'.

The final alternative for explaining how new regional paths are established involves *new path creation*. New path creation occurs from radical innovation, the implementation of new business models, user-driven innovations, or social innovations. This type of path development characterises the most radical form of development (Grillitsch & Trippl, 2016) and such processes have been described theoretically in the literature by several authors, including Schumpeter (1942 [2013]) and Kirchhoff (1994), and examples are the steam engines that gradually replaced manual work in London (and of course beyond), computers, which gradually revolutionised our lives in multiple ways, and social media which gradually revolutionised our way of communicating.

2.4.4. Remaining questions

The approach of new regional industrial path development has been researched substantially within the field of EEG. However, this line of research addresses the notion of path dependency mainly from a system perspective. Less attention has been paid to the role of key actors in new path development (Miörner & Trippl, 2017, p. 484). One such key actor is entrepreneurs and their firms, which again represent a diverse set of entrepreneurial intentions. An interesting theme for further research is thus the way in which such intentions of entrepreneurs are expected to influence further industrial path development.

Moreover, despite the fact that entrepreneurship and innovation studies have been introduced and discussed as familiar disciplines since the time of Schumpeter, the innovativeness of entrepreneurial start-ups is still under-researched. The empirical literature has predominantly addressed the theme through the lenses of large, mature firms and the analysis of huge data sets, like CIS or patent data. As such, there is an empirical gap in the literature concerning regional differences in the innovativeness of start-up entrepreneurs.

Furthermore, we know relatively little about the geography of start-up innovativeness. The literature has argued that regions are differently conditioned to promote knowledge sharing activities and that thick and diversified RISs are the regional setting that is expected to favour the most radical innovations. However, the literature has offered little empirical research to support this theoretical argument.

Finally, the newly reintroduced and further developed notion of entrepreneurial discoveries opens unexploited research opportunities within the scope of regional industrial path dependent evolution. One such theme is how various entrepreneurial discoveries support specific types of industrial path development and further how such development varies among regions. In addition, as firms represent the core of entrepreneurial discovery processes, the roles of non-core actors in such processes become interesting. Are such non-firm actors important, and if so how? How do they contribute to the process, and what is the expected outcome of their contribution?

2.4.5. How this thesis addresses the remaining questions identified

This thesis addresses these under-studied themes in article I, in article II, and in article III. Article I addresses theoretically how entrepreneurial intentions and innovativeness are expected to affect further industrial path development, while article II researches the geographical patterns of entrepreneurial growth intentions and innovativeness in thin versus thick regions. Finally, article III investigates how spontaneous entrepreneurial discoveries in various ways support specific types of industrial path development in various regional settings.

2.5. Analytical framework

The aim of this chapter has been to provide a theoretical insight into the research question of this thesis: *Which key actors and mechanisms influence new industrial path development in various regional settings?* The chapter has identified four theoretical concepts as being particularly relevant to the question addressed.

The first concept presented was the concept of knowledge. Knowledge was argued to be the main input for innovation, and the chapter argued that knowledge exists in various forms that travel differently and are sourced through different channels. Further, the presentation showed that various knowledge combinations support various types of innovation radicalism. The second concept presented was the regional innovation system approach, which argues that innovation is an interactive process that includes a wide set of actors, both regionally and beyond. The concept structures a RIS as consisting of an industry sphere and a knowledge creating and diffusing sphere and argues that regional actors are embedded in an institutional framework that can either hamper or support innovation activity in various ways. Contemporary RIS theory distinguishes between three types of RISs, recognised as thick and diversified RISs, thick and specialised RISs, and thin RISs. The third concept presented in this chapter was the concept of entrepreneurial discovery processes. The entrepreneurial discovery process was shown to be a two-step process. The first step is the initiating phase, during which the triggering idea is born, and the second step includes the following process, which involves an increased number of firms and organisations and changes in knowledge sourcing activities and partners for regional actors. The presentation distinguished entrepreneurial discovery processes into either spontaneous or planned processes. The fourth and final concept presented was the path dependency concept of industrial development. The concept argues that industrial development is anchored in history and that the evolution of industries follows historically formed trajectories encouraged by spatial organisational and institutional support. However, the theory suggests that these pathways can be changed and that such industrial path changes can take several forms. The least radical type of change is recognised as industry path extension which is not considered a dynamic alternative as it inherently supports more of the same, while the most radical type of change is described as the birth of a new industry through either industry path branching, industry path importation, or industry path creation processes.

2.5.1. Differentiated regional industrial path development

What applies to innovation also holds for research: new ideas are rarely born in isolation but most often arise from novel combinations of existing knowledge. Thus, the possible answer(s) to the main research question of this thesis is most likely to be

discovered through a process of knowledge combination. Such a novel combination of existing knowledge is presented in Table 2.2. The table presents a summary of the theoretical contributions with regard to differentiated forms of regional industrial path development. The table consists of the RIS types vertically and the process of regional industrial path development and its potential outcomes horizontally.

Overall, the proposed framework suggests that regions are differently conditioned to promote and support industrial change processes and thus that such processes and their expected outcome differ between various types of regional innovation systems.

The framework maintains that thin RISs can mostly be found in rural areas that are rich in land per capita but host a relatively meagre industrial sector and a sparse population. Further, it argues, in line with the literature, that thin RISs mainly hold an industry base that is embedded in a synthetic or symbolic knowledge base and that such regions are low in knowledge creating and diffusing organisations. From here, Table 2.2 proposes that new ideas, discovered or created by regional actors, in thin RISs are mainly recognised as incremental improvements of existing solutions and are less frequently known as radically new inventions. The framework further suggests that a relatively low local market potential combined with high transportation costs and limited possibilities for high productivity gains will induce aspirations of relatively low growth ambitions among entrepreneurs located in thin RISs. Table 2.2 further emphasises the importance of system-level entrepreneurs to thin regions because of the low number of firm actors and the suggestion that ideas in thin regions tend to focus on incremental product innovations or process innovations. Thin regions are expected to be particularly sensitive to initiatives from system-level entrepreneurs as initiators of innovation processes. Further, due to the restricted number and type of actors in thin regions, the following process of structural change is most likely to involve related intra-regional knowledge exchange in close interactions. Thus, the framework suggests that system-level entrepreneurs are important as facilitators of network-building activities outside the phase of initiation as well. Table 2.2 concludes that the most expected outcome of regional industrial path development in thin regions is path extension or intra-path changes.

Table 2.2: Summary of theoretical contributions with regard to differentiated forms of regional industrial path development

Type of RIS	Regional industrial path development		Expected outcome
	Initiating phase	Development phase	
Thin	- The initiating idea is spurred by synthetic or symbolic knowledge. - The initiating idea combines knowledge that is already known in the region. - The initiating idea is most often an incremental innovation. - Ideas from outside the region are important. - The process of discovery is most often initiated by system-level entrepreneurs.	- Low in regional knowledge hubs. - Mostly intra-regional knowledge sourcing of symbolic or synthetic knowledge. - Collaboration mainly within regional boundaries. - Low in knowledge spillovers. - Firm entrepreneurs hold low or moderate ambitions. - System-level entrepreneurs are important facilitators because thin regions lack dynamism.	Path extension or intra-path changes
Thick and specialised	- The initiating idea includes all types of knowledge. - The initiating idea most often relates to the dominating industries within the region. - The initiating idea includes radical elements. - Ideas from outside the region are important. - The process of discovery is most often initiated by firm-level entrepreneurs.	- Creation and diffusion of specialised knowledge. - Knowledge sourcing activities are less restricted by regional boundaries and include all types of knowledge. - Knowledge is mainly shared among and between firms and organisational actors with related knowledge. - High in intra-regional collaborations. - High in knowledge spillovers. - Firm entrepreneurs hold moderate ambitions. - System-level entrepreneurs are important as facilitators to avoid lock-in.	Intra-path changes
Thick and diversified	- The initiating idea includes all types of knowledge. - The initiating idea stems from diversified knowledge. - The initiating idea is high in innovativeness. - Ideas from outside are less important. - The process of discovery is most often initiated by firm-level entrepreneurs.	- The portfolio of firms and organisations is substantial and diversified. - A high degree of diverse knowledge sourcing and knowledge sharing within regional boundaries. - Rich in knowledge spillovers. - Firm entrepreneurs hold high ambitions. - System-level entrepreneurs are not particularly important as facilitators.	Intra-path changes and processes that raise new industrial pathways

Source: Authors' own

Thick and specialised RISs are recognised as having a high number of actors but as being relatively specialised in one or a few industries. Such specialisation is most often formed by historically rooted traditions and includes a well-tailored regional knowledge creating and policy support system. Such specialised regions are well tailored to drive enterprise revenues due to large and stable local markets and to allow for productivity gains from geographical proximity. Thus, entrepreneurs and firms located in thick and specialised RISs are expected to have higher growth ambitions than entrepreneurs located in thinner RISs. Thick and specialised regions are often found in old industrial regions. The frame suggests that ideas created or discovered in thick and specialised RISs are first and foremost anchored in the dominating industries and that innovations that aim to enhance the competitiveness of the local industry are prioritised. Due to the specialised knowledge creating structure, ideas generated in such regions are expected to include some analytical elements and thus to be more innovative than we would expect to find in thinner regions. Even so, the ideas are still expected to relate to the dominating industry base and thus to follow what is institutionally accepted. Table 2.2 further suggests that the process of change that results from such initiations will include collaboration or other knowledge sourcing activities, mainly technology related or industry related, situated either within or outside the region. Further, thick and specialised RISs are high in MAR externalities, including a highly competent workforce within regional boundaries and a rich level of local knowledge spillovers. These are positive for the local entrepreneurial activity. However, industry specialisation can be challenging and is not easy to address, as it involves organisational and institutional resilience towards change and the introduction of alternative industries. We, therefore, emphasises the role of system-level entrepreneurs in such environments and particularly their important role as facilitators of alternative solutions to avoid negative lock-in. Thus, the specialised organisational and institutional set-ups mostly promote intra-path changes from either path upgrading or path modernisation.

Thick and diversified RISs are recognised as having a number of actors, including a wide range of industries, and hosting a variety of R&D organisations that specialise in a range of different subjects and themes. Thick and diversified RISs are mostly found in metropolitan areas that host huge and stable local markets that allow for the benefit of economies of scale. Thus, we expect entrepreneurs who are located in such environments to hold stronger growth ambitions than entrepreneurs who are located in less favourable spaces. Thick and diversified RISs are rich in diverse knowledge

sharing alternatives, and knowledge sourcing activities in such regions are therefore expected to include a mix of all types of knowledge. Thus, ideas that are generated or discovered in thick and diversified RISs are expected to be, on average, more innovative than we would expect to find in the other two alternative regions. Finally, as thick and diversified RISs provide great opportunities for the birth of new ideas, we expect system-level entrepreneurs to be less important in thick and diversified RISs than we would expect to find in the two other types of regional settings. Thick and diversified RISs represent the most dynamic regional setting, and therefore we expect the processes that raise new industrial pathways to be the most prominent in such regions.

2.6. Theory-led assumptions

The analytical framework presented in Table 2.2 allows me to draw a set of theoretical assumptions that relates to the overall research question of the thesis. Below, I present ten theory-led assumptions. The assumptions are extracted from the analytical framework and relate to various phases of new regional industrial path development. Table 2.3 present assumptions that relates to the initiating phase, Table 2.3 presents assumptions that relates to the following phase of regional change, while Table 3.3 presents assumptions related to the final phase of industrial path change.

Table 2.3A: Theory-led assumptions related to the phase of initiation of new regional industrial path development

Theory-led assumptions	Addressed in article number
Number 1: The most radical ideas are spurred by unrelated knowledge combinations, which are best supported by regions that have a thick and diversified innovation system and are less supported in thin regions. Thus, we expect the ratio of radical entrepreneurs to be higher in thick regions than in thin regions.	II
Number 2: The RISs that are the most supportive of new path creations are most often found in urban or metropolitan areas. Such geographies represent the densest regional markets and provide the best possibilities to gain from economies of scale. Thus, one could expect entrepreneurs who launch new ventures in such geographies to have higher growth ambitions than entrepreneurs who start firms in less supportive areas.	II
Number 3: As thick and diversified RISs are the most vibrant and demonstrate the most dynamic economy with high rates of new firm formation, we expect firm entrepreneurs to be the most important initiators of entrepreneurial discoveries in such regions. Further, as thin regions are relatively low in the same parameters, we expect thin RISs to be less supportive of firm entrepreneurs and thus system-level entrepreneurs to be more active as initiators of entrepreneurial discovery processes in such regions.	III

Source: Authors' own

Table 2.3B: Theory-led assumptions related to the phase of structural change in new regional industrial path development.

Theory-led assumptions	Addressed in article number
Number 4: Thin RISs are by definition low in knowledge generating and knowledge diffusing organisations, while thick and diversified RISs are the RISs best conditioned in the scope of knowledge organisations. Thus, we expect thin regions to hold the greatest demand for new and/or adapted knowledge organisations or an inflow of knowledge from outside the region and thick and diversified RISs to have less demand for the same.	III
Number 5: As the region is the area where geographical and institutional proximity are present, one can expect knowledge exchange to take place mostly within regional boundaries.	IV
Number 6: We expect geographical proximity to be more critical to knowledge sourcing through collaboration and mobility than to monitoring. This is because firms can easily observe other organisations from a distance through monitoring, while direct interaction is more important to knowledge sourcing from collaboration and mobility.	IV
Number 7: A sound level of cognitive proximity is important for both local and non-local knowledge exchange. However, we expect non-local knowledge exchange to be more evident between firms with similar knowledge bases than between firms with dissimilar knowledge bases. This is because more cognitive proximity can compensate for lack of physical proximity.	IV

Source: Authors' own

Table 2.3C: Theory-led assumptions related to the expected outcome of new regional industrial path development

Theory-led assumptions	Addressed in article number
Number 8: As radical innovations are based on the most path-breaking ideas, we expect such innovations to support the birth of new pathways. Further, as incremental innovations are based on less radical ideas, we expect incremental innovations to support intra-path changes and path extension.	I
Number 9: For industrial growth to occur, a new or existing firm has to demonstrate attractiveness in a way that encourages other firms to follow in its footsteps. Such attractiveness is demonstrated by economic growth, and the literature has argued that the intentions of the entrepreneur are a decisive factor in gaining actual growth. As such, we expect entrepreneurs holding high growth intentions to be the best promoters of new path creation and entrepreneurs holding moderate and low growth intentions to support the renewal or extension of existing pathways.	I
Number 10: Thick and diversified RISs are seen as the most dynamic type of RIS. Thus, we expect thick and diversified RISs to be the best conditioned to promote new path creation. Following the same logic, we argue that thin RISs mostly foster path extension.	III

Source: Authors' own

3. Research design

A doctoral thesis is a piece of academic knowledge creation that is strongly influenced by the worldview of the candidate. Thus, being aware of and transparent about one's general assumptions regarding what exists in the world (ontology) and one's assumptions about how we can come to know the world (epistemology) are especially important for researchers. Such awareness and transparency are essential because the ontological and epistemological stances of the researcher influence methodological questions regarding how the researcher can 'go about finding out whatever he or she believes can be known' (Guba & Lincoln, 1994, p. 108).

This chapter includes a presentation of the ontological, epistemological, and methodological approaches that have guided this thesis as well as a description of the methods used to collect and analyse the data. The chapter closes with a reflection on the ethical considerations.

3.1. Ontological and epistemological underpinnings

Ontology refers to a set of thoughts and presumptions that relate to 'the set-up and constitution of all reality and the problems/opportunities of existence' (Arbnor & Bjerke, 2009, p. 424). Thus, ontological questions are questions in science that deal with what exists in the world, in other words how things really are. Epistemology, on the other hand, relates to our understanding of what we think can be known about this reality or 'the philosophical theory of the nature and grounds of knowledge' (Arbnor & Bjerke, 2009, p. 420). Because they deal with fundamental questions about reality and knowledge, the ontological and epistemological assumptions of the researcher will influence the research in several ways, including the choices of methodology (Guba & Lincoln, 1994).

A paradigm can be understood as a 'belief system' (Guba & Lincoln, 1994, p. 107) that includes ontological, epistemological, and methodological questions. Such belief systems form research traditions that have reached a consensus on fundamental questions regarding the world and how we can come to know it. Two contrasting philosophical paradigms are positivism and constructivism. In short, the positivist

approach advocates an objective ontology and a dualist epistemology. Thus, this position argues that the world is real and perfectly apprehensible and that the researcher can study this real world without influencing it or being influenced by it. Consequently, for positivists, metaphysics is not part of science and researchers should, therefore, look for concrete evidence and rules in the social sciences just as in the natural sciences. For constructivists, on the other hand, reality is understood as a subjectively constructed phenomenon formed 'through interpreting perceptual experiences of the external world' (Jonassen, 1991, p. 10). The constructivist paradigm argues that knowledge is socially and culturally constructed and that knowledge, in research, is, therefore, best created through processes of interaction between the researcher and the object of investigation.

This thesis distances itself from the positivist and constructivist paradigms and is influenced by the research tradition of critical realism (CR). CR is a paradigm that is situated somewhere between the two positions of positivism and constructivism. Critical realists advocate a realist ontology with a constructivist epistemology. Thus, CR represents a philosophical perspective that argues that a real world exists and that this existence is independent of theories, constructions, or perceptions. However, CR further states that 'our understanding of this real world is inevitably a construction from our own perspectives and standpoint, and there is no possibility of attaining a "God's eye point of view" that is independent of any particular viewpoint' (Maxwell & Mittapalli, 2010, p. 146).

Following this approach of a realist ontology and a constructivist epistemology, critical realists argue that the world exists independent of our knowledge of it (Sayer, 1992). This argument rests on a distinction between the intransitive and transitive dimensions of knowledge. According to CR, the transitive dimension relates to our knowledge about the world expressed in theories, paradigms, models, or concepts, while the intransitive dimension of science includes the real objects about which science aims to gain knowledge. Sayer provides an example of the difference between the transitive and the intransitive dimension of knowledge, saying: '.there is no reason to believe that the shift from a flat earth theory to a round earth theory was accompanied by a change in the shape of the earth itself' (Sayer, 2000, p.11).

Critical realism further argues a stratified ontology (Bhaskar, 1978) and distinguishes between three strata of the world, namely the real, the actual and the empirical. To

critical realists, the domain of the real refers to ‘objects and structures with inherent causal powers and liabilities which result in mechanisms that may not be visible’ (Zachariadis, Scott, & Barrett, 2013, p. 3). Thus, according to CR, the aim of scientists should be to reveal these structures and powers of the objects of the ‘real’ through the transitive dimension of science. The ‘actual’, on the other hand, ‘refers to what happens if and when those powers are activated, to what they do and what eventuates when they do’ (Sayer, 2000, p. 12). The ‘empirical’, in turn, represents what can be experienced or observed.

CR further holds that the world is characterised by emergence. Emergence is known as a situation ‘in which the conjunction of two of more features or aspects gives rise to new phenomena, which have properties which are irreducible to those of their constituents, even though the latter are necessary for their existence’ (op.cit., p. 12). Such internal relations dominate the social world where individuals are embedded in social structures, cultures, norms and values, and are most often formed by, and depend on, their relation to others.

The analysis of causation is a distinctive feature of realism. While to positivists, causality is understood from a model that involves regular successions of events, critical realists argue that causality can be revealed only by ‘discovering the nature of the structure or object which possesses that mechanism or power’ (op.cit., p. 14). The weakness of the positivist approach to causality is, according to Bhaskar, that their concept of law is tied to closed systems. Critical realists, on the other hand, argue that the world is an open system in which emergence unfolds. Important to critical realism is thus, that due to this interactivity, the same causal power can produce different outcomes as this power might be influenced by other objects that modify its outcome (op. cit.).

3.2. Methodology

Methodology relates to the question of how we come to know the world from a more practical angle than epistemology. Methodology focuses on alternative routes through which we can gain knowledge about the world, and these routes typically consist of

systems of methods that should, or could, be used to gain practical knowledge of the phenomenon of study. However, as pointed out earlier, methodology is closely related to the ontological and epistemological positioning of the researcher. Therefore, the preferred systems of methods used in research are not randomly distributed among researchers. An example of such close relations between philosophical position and methodology is found in the distribution of qualitative and quantitative research approaches. When referring to the two extreme philosophical positions presented earlier, the qualitative research approach most often pairs up with constructivism, while the quantitative research approach strongly links to positivism or post-positivism (Maxwell & Mittapalli, 2010).

As discussed previously, critical realism positions itself between positivism and constructivism, advocating a combination of realist ontology and constructivist epistemology. An essential tenet then is, as pointed out earlier, that ontology is not reducible to epistemology; in other words, the world is more than we can see, as it exists independently of our knowledge of it (Sayer, 1992). Thus, according to critical realists, the crucial role of science is to reduce the distance between the transitive and the intransitive dimension by continually aiming to reveal structures and mechanisms that are anchored in the real domain. Or, as stated by Bhaskar, ‘the aim of science is the production of the knowledge of the mechanisms of the production of phenomena in nature that combine to generate the actual flux of phenomena of the world’ (Bhaskar, 1978, p. 6).

Critical realism introduces retroduction as an important approach to help unmask the real. Retroduction refers to a dialogue between abstracts and concretes or, in other words, between theoretical reasoning and conceptualisation on the one hand and empirical research on the other. To critical realists, abstract research is important on its own. It is important because, by abstraction, researchers can conceptualise the phenomenon in a way that makes it more empirically manageable. Sayer (1992) addressed this issue by stating that: ‘our concepts of concrete objects are likely to be superficial and chaotic. In order to understand their diverse determination, we must first abstract them systematically. When each of the abstracted aspects has been examined, it is possible to combine the abstraction, so as to form concepts which grasp the concreteness of their objects’ (Sayer, 1992, p. 87). However, as mentioned above, critical realists argue that abstraction should not be an isolated activity but rather should be in constant dialogue with empirics. CR further argues that this dialogue

should cause a refinement of the abstraction so that it increases its ability to explain the phenomenon in question. This is the purpose of the routine of retroduction. Retroduction can be exemplified from the starting point of an empirical observation, which continues with the abstraction of a possible relation between the empirical (what we observed) and the real (the more profound causal powers and structures). From here, the process continues as more empirical evidence is collected and tested in terms of the abstraction. If contradictions between empirics and abstraction are evident, then the process continues as a re-iterating loop between theory and practice until the abstraction appears to be robust enough to grasp the concreteness of their objects.

The second important methodological principle stemming from the philosophical position of critical realism is triangulation. Triangulation, qualitative researchers have argued, is a strategy that increases the probability of researchers improving their chances of uncovering the real (Denzin, 1970). According to Patton (1999, p. 1192), the term ‘triangulation’ originates from the profession of land surveying and refers to the benefits of having two landmarks instead of one. Knowing one landmark only locates one’s position in relation to this landmark alone, whereas with two landmarks it is possible to locate one’s position in two directions. In critical realism, triangulation is an important principle that reduces the risk of bias-based misconceptions. This focus on bias is a consequence of the constructivist epistemological stand of critical realism, which argues that all individuals are biased in some way. Thus, critical realists argue that adding more views to the phenomenon under investigation increases the robustness of the research process and improves the chances of revealing elements of the real (Sayer, 1992, 2000).

Four different forms of triangulation often referred to in the qualitative research literature, are; data triangulation, which refers to the use of different sources of information spread across different times and situations; investigator triangulation, which involves the use of more than one investigator to collect and analyse the relevant data; theory triangulation, which involves the use of multiple perspectives to interpret data; and, finally, methodological triangulation, which can involve the use of several variants of the same method and/or the use of different methods to generate data (see e.g., Denzin, 1970; Downward & Mearman, 2006).

As indicated above, methodological triangulation can take two forms. Denzin (1970) named the two forms ‘within-method’ triangulation and ‘between-method’

triangulation. While the former version involves the use of several varieties of the same method, the latter implies combining data that are generated by both intensive and extensive research (Sayer, 2000). When explaining the difference between intensive and extensive research, Easton noted that intensive research 'focuses on individual agents in context using interviews, ethnography and qualitative analysis, asks the question "what produces change?"' Meanwhile, extensive research 'employs large scale surveys, formal questionnaires and statistical analyses, looking for regulatives, patterns and similarities, accepts given taxonomic categories, privileges replication and has restricted ability to generalise to other populations and limited explanatory power' (Easton, 2010, p. 123). As discussed previously, a mix of qualitative and quantitative research approaches can be a challenge for researchers holding extreme positions as positivists or constructivists (Maxwell & Mittapalli, 2010, p. 146). This challenge results from their ontological and epistemological stance as researchers. If researchers argue a positivistic approach to social science, they will seek unambiguous data and concrete evidence that can form general rules. Thus, including more interpretive and soft data can be problematic, as they most certainly will be biased and insignificant. To constructivists, the same logic may be used the other way around; adding patterns of distribution as evidence can be conflicting and irrelevant, as it says nothing about the causes of action that they aim to reveal.

Critical realists, however, embrace both intensive and extensive research methods as valuable. They assert that, if performed and interpreted correctly, multi-method research and mixed-method research check the reliability of the data and the validity of the research process and the results. That is, 'In short, "within-method" triangulation essentially involves cross-checking for internal consistency or reliability while "between-method" triangulation tests the degree of external validity' (Jick, 1979, p. 603).

Questions related to the ontological, epistemological, and methodological stances of researchers are most often subject to maturation. This applies equally to the author of this thesis. When starting the PhD, my ontological and epistemological understanding was not fully developed, as, I have been told, is the case for most candidates. Finding my position as a researcher has been a process that has involved courses and discussions as well as methodological experimentation. Today, still not fully mature as

a researcher, I identify[17] as a critical realist. Thus, being methodologically diverse corresponds to my worldview and my position as a researcher.

3.3. Methods

Methods represent the third layer of practical implications discussed in this research design chapter. As argued previously, these three layers are paradigmatically connected, as the ontological and epistemological positions of the researcher will affect what he or she considers to be the appropriate methodology, which, finally, will influence the techniques that he or she believes can be used to collect and analyse relevant data.

This sub-section presents and discusses issues of relevance to methods and is structured as follows. First, the section describes how the four articles and the thesis relate to some core concepts of research in critical realism before it continues by elaborating on two main questions that link to the methodological part. These questions concern a) how the approach of retroduction has been carried out in this thesis and b) how various forms of triangulation have been applied. The sub-chapter ends with an elaboration of some ethical considerations that follow the implemented techniques.

3.3.1. Units of analysis, objects, and events in the various articles and in the thesis

This doctoral thesis researches new regional industrial path development from a system perspective. It builds on the logic that there is a difference between the whole and the sum of its objects of interests (Sayer, 2000). This divide, the thesis suggests, occurs because the relations between the objects will produce either positive or negative synergy. Thus, systems can create either more or less than the result of the sum of individual actors' activity.

[17] Even still learning and developing

This thesis provides a diverse set of evidence within and between the articles included. As a whole, the unit of analysis of the thesis is the process of new regional industrial path development, but this process is researched from several angles and in various stages by the four articles.

Key concepts of CR are objects and events. In CR, objects refer to entities that hold causal power and liability to cause change. Such objects can be human but also non-human, such as relationships, resources, innovations, ideas, and more. According to Easton (2010, p. 120), objects can be 'human, social or material, complex or simple, structured or unstructured'. As they represent the cause of change, objects are separate from the concept of variables used in more quantifiable research. This is because 'variables can only register (quantifiable) change, not its cause' (Sayer, 1992, p. 180). Events, on the other hand, are the focus of critical realists' research. Alternatively, as pointed out by Easton (2010, p. 120), 'that is the external and visible behaviours of people, systems and things as they occur, or as they have happened'. In the following, an article-to-article presentation of how the four included articles address the key concepts of CR is provided. Observe that the numbering of the various papers follows the logic of the theme more than their relative importance.

Article I addresses the process of new regional industrial path development in its phase of initiation and adds an abstract, conceptual contribution to the thesis. In article I, the unit of analysis is entrepreneurial firms, and the object of interest is individual entrepreneurs. The events addressed in the paper are the responses that new start-ups cause to the regional industry. However, as this paper builds solely on deductive reasoning, these events are theoretically constructed and not empirically observed.

Article II is a strictly quantitative contribution that addresses the relation between entrepreneurial growth intentions and entrepreneurial innovativeness on the one hand and contextual settings on the other hand. The paper intends to detect possible geographical patterns of various forms of entrepreneurs, and the unit of analysis is entrepreneurial firms. As article II makes a quantitative contribution to the thesis, it typically addresses variables that are to be understood as quantifiable measures of change and not as evidence of the causes of change. The variables researched in this article are the growth intentions and innovativeness of entrepreneurs and the regional context as well as a set of argued control variables.

Article III examines how various regional contexts influence the process of spontaneous entrepreneurial discoveries and, further, how such discoveries support specific types of industrial development in various regional settings. The unit of analysis is the entrepreneurial discovery process, and the objects are individuals and organisations within the RISs investigated. The events in this study are the initiation of the discovery as well as the RIS changes that this initiation has caused.

Finally, article IV researches the geography of innovation networks within an emerging industry in Bergen. The unit of analysis in this paper is the regional industry, and the objects are regionally located media firms. The events are collaborations, mobility, and monitoring activity, which are investigated through structural interviews and relational data.

Collectively, the papers address the question of *which key actors and mechanisms influence new industrial path development in various regional settings?* Thus, the unit of analysis in this doctoral thesis is the process of new regional industrial path development. The objects are entrepreneurs, firms, and other regional entities identified as part of the actual regional innovation system, and the events are the entities and structural changes caused by the initiating discoveries. Additionally, the thesis draws on analysis that detects the geographical patterns of entrepreneurs within various regional settings as well as patterns of collaboration, mobility, and monitoring between diverse knowledge based firms within one additional region.

In this thesis, events are researched through data that are reported and not observed. Thus, the data are most certainly biased and need to be interpreted carefully. Further, the thesis deals with historical data. Such data are filtered by several layers of memory losses and, therefore, to include alternative sources and try to grasp the story from more than one angle can be a useful strategy to reduce the effect of such biases.

Table 3.1 finalises this subsection by providing a schematic overview of the articles in relation to the objects of study, events, and contextual settings.

Table 3.1: The four articles and their key concepts

Article	Object of Study	Events	Context
I	Individual entrepreneurs	Responses that new start-ups cause to regional industries	Regions in general
II	Entrepreneurial start-ups	The geographical clustering of firms from growth intentions and innovativeness	Two thick and six thin RISs within the area of Agder
III	Individuals and organisations within the RIS	How the regional context affects EDPs and how EDPs support the development of RISs	The thick RIS of Oslo, the thick and specialised RIS in Møre, and the fairly thin RIS in Hamar
IV	Regionally located media firms	Collaboration, mobility, and monitoring activity among firms	The thick and diversified region of Bergen

Source: Authors' own

3.3.2. Abstract research and the approach of retroduction in the various articles

Abstraction has been practised as a regular exercise during the work on this doctorate. This ongoing practice of theoretical reasoning and conceptualisation has been carried out through a comprehensive literature review. Relevant domains of literature include entrepreneurship, innovation studies, and the economic geography literature as well as related areas within the domains of economy, philosophy of science, and policy. From this broad range of literature, a variety of conceptual and analytical frameworks, alternative concepts, conceptualisations, and lines of arguments have been discussed and challenged. Thus, each article includes abstractions that have been theoretically challenged, formed, and advanced to suit the research questions of the article. However, as highlighted by the retroduction routine, theoretical constructs should also be in dialogue with empirics so that contradictions can be reduced and the robustness

of the abstraction can be increased. Such dialogues have been an important part of all the empirical articles, both during the research process and as part of the discussions and conclusions. Finally, such retroduction is also evident in the overall thesis. In the following, an article-to-article presentation of the way in which abstraction and retroduction have been carried out in the various articles is provided.

Article I offers a theoretical contribution to the thesis. This article abstracts the phenomena of growth intention and innovation and elaborates on their inherent causal power potentially to influence the further development of their regional industry. The main contribution of the paper is a suggested typology of entrepreneurial firms' expected contribution to future industrial path development. Retroduction has been an important routine in the process of writing and researching this article. The original idea of the suggested model of typologies arose years ago and was inspired by my own experience as an entrepreneur. Four years ago, I gained the chance to explore this experienced and observed phenomenon in depth through a research project. The research project allowed me to collect a rich variety of empirical data and to discuss the appropriateness of the abstractions with colleagues in formal and informal forums. The research assignment referred to was published as an R&D report by Agder Research (Rypestøl, 2014) and includes an early version of the typology.

Article II refers to the initiating phase of new regional industrial path development and researches the geography of entrepreneurial growth intentions and the geography of entrepreneurial innovativeness. In this article, entrepreneurship theory and innovation theory form the conceptual framework of the abstracted concepts, while the agglomeration argument is highlighted as the most important argument to support the expected patterns of geography. This paper relates to article I, as it activates some of the collected survey data that were collected in the research process of that paper. Thus, the process of retroduction referred to in article I also underlies paper II.

Article III focuses on successful EDPs in various regional settings. The paper is rooted in the theoretical landscape of regional innovation systems, entrepreneurial discovery processes, and path dependency, and from there the paper presents a reflection and a discussion that are finalised in a suggested analytical framework. During the research process, this suggested framework was challenged and changed several times as new empirical findings proved that previous suggestions were not suitable. Thus, the routine of retroduction guided the process of completion of this article.

Article IV investigates knowledge sourcing activities among member firms of an emerging cluster. Thus, this paper addresses the stage of industrial emergence and change. Paper IV leans towards the notion of knowledge bases when it conceptualises cluster firms as being either synthetic or symbolic knowledge dominant. From here, the paper builds on the theory of the nature of knowledge networks by reflecting on the possible patterns of combinatorial knowledge dynamics that are evidenced amongst cluster firms. Empirical devices, the abstracted conceptualisation, and dynamics are challenged by two sets of data that include descriptive and relational data.

Table 3.2 presents a summary of the theoretical frame, researched phenomenon, and empirical data collected for the four articles.

Table 3.2: The various articles and their elements

Article	Theoretical frame	Researched phenomenon	Empirical data
I	-Entrepreneurship -Innovation studies -Path development --RIS theory	A typology that links entrepreneurial growth intention, innovativeness, and further industrial path development	- No empirical data included
II	-Entrepreneurship -RIS literature -Innovation studies -Cluster theory	The geography of growth ambitions and innovativeness	- Survey data from 917 entrepreneurial start-ups
III	-RIS theory -EDP -Path dependency	An analytical framework that links regional context, entrepreneurial discovery processes, and regional industrial path development	-14 in-depth interviews -Survey data from 44 firms

IV	-Innovation networks -RIS theory -Knowledge sourcing -Knowledge bases -Proximity	The geography of combinatorial knowledge dynamics	-Structural interviews with 22 media firms -Three sets of relational data for 22 media firms -Document studies

Source: Authors' own

3.3.3. How triangulation has been carried out in this thesis

As described previously, triangulation is a technique that is widely used by critical realists. The main reason for practising triangulation is that it can increase the validity as well as the reliability of the research (Downward & Mearman, 2006, p. 6). Triangulation can contribute to increased validity, as it activates more than one viewpoint, and it can increase reliability, as it might include more than one method of data collection and more than one method of analysing the collected data. In the following, an article-by-article description of the way in which triangulation has been carried out within this thesis is presented.

Article I is a theoretical single-authored article. Even so, the process of writing and elaboration was an open process, strongly influenced by other researchers. The article was presented and discussed in several formal and informal forums at Agder Research as well as at the University of Agder. Further, it was presented and commented on at the RSA conference in Piacenza in May 2015, and it was scrutinised by an international group of regional development researchers[18] in January of the same year. The discussions and received comments all played a major role in forming the content and the structure of the article. Finally, the article was examined by the peer review process of an academic journal. The first draft received valuable comments, which were followed up in a rewrite. In the second round, the article was accepted for publication. Thus, even though article I contains no triangulation, the article has

[18]Researches participating in 'Programme for Regional R&D and Innovation' (VRI)

followed a route of repeating discussions, rewriting, and improvements. Article I was published online in February 2017 by *Journal of Innovation and Entrepreneurship*.

Article II is grounded in an extensive research tradition, as it searches for geographical patterns of growth intentions and innovativeness among 917 start-up firms. The applied data were collected from a tailored survey distributed to 6993 startup firms in the area of Agder. The paper was co-authored with Professor Jarle Aarstad at the Western Norway University of Applied Sciences. Although the authors provided different sections of the article, the various parts of the papers were evaluated and discussed collectively. These discussions caused changes to the theory, conceptualisations, and analyses. Thus, the paper successfully practises investigator triangulation. Further, the paper applies theoretical triangulation, as the tested hypothesis is derived from a multidisciplinary theoretical foundation. Furthermore, article II makes use of within-method triangulation to increase the validity of the findings. This within-method triangulation is evident, as the article draws from several variants of quantitative research methods when analysing the data. These variants include descriptive statistics, ordinal logistical regression, bootstrapping, and coarsened exact matching. During the face of submission, the article has been thoroughly examined and commented on by excellent reviewers. We have received highly valuable comments and have rewritten our paper following these suggested changes. Article II is accepted for publication and forthcoming in *Journal of Entrepreneurship and Regional Development*.

Article III draws from all the types of triangulation named. The paper researches the entrepreneurial discovery process from its successful initiation to its development into the formation of an official cluster. The paper applies an intensive research approach and proposes a conceptual framework that is suggested to improve our understanding of such processes. The paper was co-authored by four researchers, who contributed equally to the article. The researchers have different backgrounds and experience, and all the team members contributed to collecting the data, analysing the findings, and writing the article. The presented article is a result of a loop of discussions and rewrites. From this, article III can be recognised as a work that has been improved by investigator triangulation. Further, the data were analysed in light of a multidisciplinary theoretical foundation. Thus, the paper also benefits from theoretical triangulation. Thirdly, two sets of data were collected as empirical evidence in this article: 14 in-depth interviews and 44 responses from a tailored survey of 74 cluster

firms. The survey was analysed with the use of descriptive statistics, while the interview data were analysed using qualitative methods. Thus, article III applies both qualitative and quantitative research methods and thus practices between-methods triangulation. Fourthly, article III gathered data from multiple sources in 3 destinations over a span of 6 months. Thus, the paper benefits from data triangulation. Article III is in the peer review process in *Regional Studies*. The first draft of the article has been significantly modified in accordance with feedback from highly skilled reviewers. The paper is now in its second round of reviews.

Article IV follows a case study design to examine the phenomenon of innovation within the media cluster in Bergen. This paper is 50/50 co-authorship by me and the senior lecturer Roman Martin at the University of Gothenburg. The authors discussed the paper in numerous meetings, and various sections of the paper have been rewritten and reformulated several times. Thus, paper IV benefits from investigator triangulation. In article IV, the theoretical framework builds on the combined literature on innovation and regional development, and both traditions were applied when analysing the data. As such, the paper benefits from theoretical triangulation. Further, the paper draws empirically from descriptive and relational data that were collected from structural interviews with 22 media firms. To analyse these data, we adopted both extensive and intensive research methods. We applied the method of social network analysis to display the network graphs of the various knowledge sourcing mechanisms, while we activated softer interview data to diagnose the dominant knowledge base and to supplement the discussion of geography and flow. Thus, between-method triangulation has advanced this article. Finally, article IV was presented at the AAG conference in San Francisco in March/April 2016 and has been shaped through the peer review process of *Industry and Innovation*. The paper was published in June 2017.

As described above, the included articles are formed through extensive triangulations. Triangulation has been carried out to improve the research and to better the chances of uncovering causality and structures of the real.

Table 3.3 contains a visual presentation of the distribution of triangulations practiced in this thesis.

Table 3.3: Triangulation within the four articles

Article	Methodological	Investigator	Data	Theoretical
I	NO	NO	NO	NO
II	YES (Within method)	YES	NO	YES
III	YES (Between method)	YES	YES	YES
IV	YES (Between method)	YES	NO	YES

Source: Authors' own

Finally, this capstone paper has, as have the articles, been advanced through dialogues and shared reflections. First, parts of the kappa have been thoroughly discussed with fellow students and have, through these discussions, received feedback important to enhance its quality. Second, earlier versions of the kappa have been commented separately by my two supervisors, and their constructive advice has been discussed and commented in following dialogues. This thesis has benefitted from their constructive and insightful recommendations. Third, an earlier version of the kappa was critically reviewed and commented by Professor Michaela Trippl[19] during a pre-defence in Oslo, November 21st, 2017. Professor Trippl gave generous advice and led a constructive dialogue which was helpful to further develop the kappa.

[19] Michaela Trippl, Professor of Economic Geography, University of Vienna

3.4. Ethical considerations

The Norwegian National Research Ethics Committee provides guidelines for research ethics in the social sciences.[20] According to the committee, 'research ethics' refers to 'a wide variety of values, norms, and institutional arrangements that help constitute and regulate scientific activities' (NESH, 2016, p. 5), and the purpose of such guidelines for research ethics is to provide 'researchers and the research community with information about recognised norms of research ethics' that intend to 'help develop ethical discretion and reflection, to clarify ethical dilemmas, and to promote good scientific practice' (op. cit.).

I have thoroughly studied the guidelines provided and, to the best of my knowledge, fulfilled their intentions. This applies to the norms that constitute good scientific practice (like openness and trustworthiness), the norms that regulate the research community (like integrity and impartiality), the norms regarding the relationship with people who take part in the research (like respect, human dignity, and free and informed consent), and finally the norms that address the relationship with the rest of society (like independence, conflicts of interest, social responsibility, and more).

The empirical data in this thesis were provided by individuals representing small or large firms or organisations. No personally sensitive information was collected. However, my colleague researchers and I earned the trust to interpret and make conclusions from this material independently of the informants' check of whether we had understood their message correctly. I am grateful for this, and we have tried our utmost to use the information provided in the manner in which we believe was the original intention. The analysis of the data provided was conducted to the best of my ability and in close discussion with more experienced researchers. All the data were anonymised in accordance with the agreement, and I believe that this thesis complies with a high ethical standard.

[20] Accessible at https://www.etikkom.no/forskningsetiske-retningslinjer/Samfunnsvitenskap-jus-og-humaniora/

4. Findings and conclusions

In this chapter, I present and discuss the main findings of the included articles. In sum, the findings seek answers to the overall research question of the thesis, which is the following: *Which key actors and mechanisms influence new industrial path development in various regional settings?*

As argued previously, the included articles shed light upon the overall research question by investigating the theory-led assumptions presented in Table 2.3 A–C. Following the structure of these tables, the chapter starts with a discussion of the findings that relate to the initiating phase of new regional industrial path development. From here it continues by discussing the findings related to the following process of change before it presents the findings related to the expected outcomes of new regional industrial path development.

The chapter concludes by providing a presentation of the overall contribution of the thesis concerning key actors, mechanisms and the role of geography in new industrial path development.

4.1. New regional industrial path development: The initiation

Anchored in the analytical framework, the thesis raises three theoretical assumptions which relate to the initiation of new regional industrial path development. These assumptions are displayed in Table 2.3A and suggest that thick regional innovation systems provide the best context for innovative entrepreneurs (*assumption number 1*) and that entrepreneurs located in such RISs hold higher growth ambitions than entrepreneurs located in thin RISs (*assumption number 2*). Finally, Table 2.3A suggests that the importance of system-level entrepreneurs as initiators of EDPs is inversely correlated with regional thickness and diversity (*assumption number 3*).

In the RIS literature, RIS thickness is most often discussed and argued following a case study design, which includes relatively few comparable quantitative data. Article II, however, suggests ten quantitative variables as being particularly influential in evaluating RIS thickness. The paper asserts that RIS thickness is a relative term and

compares neighbouring RISs in the Agder area of southern Norway using these ten variables. On the basis of these ten variables, the paper classifies two RISs as thick and six RISs as thin within the Agder area. Following this classification of thin and thick RISs, article II further investigates whether entrepreneurs placed in thick RISs are (subjectively measured) more innovative than entrepreneurs located in thin RISs (*assumption number 1*) and whether entrepreneurs located in thick RISs have stronger growth ambitions than those found in thin RISs (*assumption number 2*). From the tailored survey data, the paper concludes positively regarding the first question, however, finds no evidence to support the second assumption.

Article III suggests a distinction between firm-level entrepreneurs and system-level entrepreneurs. The paper defines firm-level entrepreneurs as individuals who establish new innovative firms or who carry out innovation activities in existing firms, while system-level entrepreneurs are understood as individuals or organisations who are able to reconfigure RISs. The analytical framework suggests that system-level entrepreneurs are increasingly important in thin versus thick RISs. The presented case data and the following discussion conclude that a distinction between firm-level entrepreneurs and system-level entrepreneurs is productive both conceptually and empirically. It further suggests that system-level entrepreneurs are equally important as initiators of EDPs in the case of thick RISs as in the case of thin RISs. Referring to these findings, the article concludes by highlighting the importance of system-level entrepreneurs as initiators of EDPs in all geographical settings. Thus, *assumption number 3*, stating that system-level entrepreneurs are more important as initiators of EDPs in thin RISs than in thick RISs, is not supported in this article.

4.2. New regional industrial path development: The process

The analytical framework includes four assumptions that relate to the process following the successful initiation of new regional industrial path development. These four assumptions are presented in Table 2.3B. They suggest that there will be an increasing need for new and adapted knowledge creating and -diffusing organisations as one moves from thick to thin RISs (*assumption number 4*) and that knowledge exchange most often takes place within regional boundaries (*assumption number 5*). Table 2.3B further implies that various knowledge sourcing mechanisms are unevenly

geographically sensitive (*assumption number 6*) and finally that firms with similar knowledge bases are the least restricted to regional boundaries (*assumption number 7*). These assumptions are investigated in articles III and IV.

Article III argues that the changing structures of RISs can be identified by analysing the establishment of new organisations and new and improved relations. The article further suggests that new and adapted knowledge creating and -diffusing organisations are an important RIS change, and it researches *assumption number 4*, which suggests that the establishment of such knowledge organisations will be more evident in EDPs that take place in thin RISs than in EDPs that occur in thick RISs. The argument behind this assumption is that knowledge creating- and diffusing organisations are scarce or non-existent in thin regions. Empirically, article III demonstrates that change within the knowledge sub-system is an important indicator of RIS changes following successful EDPs. The empirical evidence in article III finds that the establishment of new knowledge organisations differs between regions, but the findings do not fully support assumption 4. The paper concludes that '… we do not maintain that the establishment of new knowledge organisations is always more important in the entrepreneurial discovery process in thick and specialised and thin RISs' (article III, p. 19).

Article IV analyses the geography of knowledge sourcing from a single cluster perspective and addresses the assumptions presented as numbers 5, 6 and 7. When discussing the importance of the region as a location for knowledge exchange (*assumption 5*), the article presents evidence supporting the assumption that the region is a key arena for knowledge sourcing. The article finds that, in the media industry located in the thick and diversified region of Bergen, the region is the most prominent geography for all the types of knowledge exchange investigated regardless of the type of firm.

Article IV further investigates the importance of geography to various forms of knowledge sourcing mechanisms in the media industry (*assumption number 6*). The article finds that mobility is the mechanism that is the most sensitive to space in this industry and further that monitoring is the researched mechanism that is the least geographically restricted. The paper suggests that monitoring is the least bound to spatial proximity because direct interaction is not needed to activate this channel. It

further implies that mobility is the mechanism most bound to geography as skilled workers tend to locate in their home community.

Further, article IV researches the theoretical *assumption number 7.* This assumption suggests that similar knowledge based firms are less geographically restricted in their knowledge exchange than firms with different knowledge bases. The argument behind this assumption is that cognitive proximity can compensate to some extent for lack of co-location. Article IV finds no evidence to support such discrimination of geography in collaboration. The network data show a clear overweighting of regional knowledge exchange for both similar and dissimilar knowledge based firms, as suggested by assumption 5, but no significant difference in the pattern of non-regional knowledge exchange as suggested by assumption 7. 'Consequently, the region can be seen as key area for firms to both strengthen their core competences by exchanging knowledge with cognitively similar organisations, and to diversify and go beyond existing competences by collaborating, monitoring and recruiting from organisations with dissimilar knowledge base' (Martin & Rypestøl, 2017, p. 18).

4.3. New regional industrial path development: Possible outcomes

Table 2.3C presents three theoretical assumptions that relate to the possible outcomes of new regional industrial path development. These three assumptions are addressed by articles I and III. Article I investigates assumption number 8 and assumption number 9, while assumption number 10 is researched in article III.

As article I is a theoretical contribution, *assumption number 8 and assumption number 9* are researched from a theoretical perspective only. By referring to earlier literature following a wide range of approaches, article I argues in line with assumption number 8 and assumption number 9. The article argues that ideas that are new to the region are the most potent ideas and further, that entrepreneurs who hold high ambitions to grow their firms are the most potent entrepreneurs. In article I, potent refers to the ability to support new path development through path renewal or new path creation. Article I suggests four types of new entrepreneurial firms that are distinguished by their ability to affect future industrial development. The four categories of firms are labelled A, B, C, and D, of which firm type A is the most potent category and firm type D is the least

potent one. Firm A represents the combination of an idea that is new to the region and an entrepreneur with a high ambition to grow, while category D represents firms that combine ideas that are already known to the region and entrepreneurs with low intentions of growing the firm. Finally, firm types B and C represent two hybrids. Article 1 argues theoretically that the ability of a new entrepreneurial firm to promote new path creation decreases as the new firm moves from category A to category D.

In article III, the presented model suggests that the expected outcome of EDPs is influenced by the dynamics of the RIS. This research responds to the theoretical *assumption number 10*, which argues that thick and diversified RISs are best conditioned to stimulate new path creation and further that thin RISs mostly foster path extension. As an overall finding, article III concludes that it is useful to analyse potential regional industrial path development from the previous EDPs. This is useful because 'different path developments signify various "qualitative shifts" in the regional economy; the creation of new regional industries or the strengthening of existing ones' (article III, p. 20). This variety is exemplified by the case studies, which identify some chances to involve more of the same while others are identified as including more radical changes, like new ventures established in new regional industries. When researching the geography of path developments, article III finds that the most radical regional path development outcome is identified in the thick and diversified RIS of Oslo, while the least radical outcome is identified in the process embedded in the fairly thin region of Hamar. These findings support the theory-led assumption number 10.

4.4. Conclusions

The findings presented in the four articles provide a conclusion following three main themes. These themes are presented in the following and refer to actors, mechanisms, and geography.

Regarding actors, this thesis argues and demonstrates that new regional industrial development follows path dependent processes, which include a wide set of actors.

The thesis pays significant notice to the role of entrepreneurs in new regional industrial path development, and it identifies and researches entrepreneurs at two different levels. These entrepreneurs are firm-level entrepreneurs and system-level entrepreneurs. Following the line of firm-level entrepreneurs, the thesis expands our knowledge of the role of such entrepreneurs in new regional industrial path development by presenting analytical and empirical evidence that indicates a link between entrepreneurs' characteristics and the potential outcome of regional industrial path development processes. The thesis argues that entrepreneurs that hold the most radical combination of innovativeness and growth intentions are the once best suited to promote industrial path creation, while the entrepreneurs holding the poorest combination of the same, mostly foster industrial extension. The thesis further maintains that entrepreneurs that hold the two remaining combinations of entrepreneurial growth intentions and innovativeness are most likely to promote new industrial path development in the form of industrial path renewal.

Further, following the line of system-level entrepreneurs, this thesis introduces and demonstrates the important role of system-level entrepreneurs in new regional industrial path development. It presents empirical evidence that system-level entrepreneurs can be crucial to new regional industrial path development, as they can act as initiators as well as drivers of RIS changes. The thesis argues that system-level entrepreneurs create and improve structures as well as external support and thereby enhance innovation. However, it also stresses that firm-level entrepreneurs must utilise the possibilities raised by system-level entrepreneurs if the process of change is to continue. Finally, the thesis argues that system-level entrepreneurs are important to the process of institutionalisation of change.

Focusing on mechanisms, the thesis asserts and demonstrates that knowledge sourcing is a key mechanism in new regional industrial path development. The argument stems from three significant findings in the literature. These findings report that knowledge is a key resource for innovation, that innovation is vital to new regional industrial path development, and that firms seldom innovate in isolation. Thus, gaining a better understanding of how knowledge is transferred and created becomes important to increase our understanding of the processes of new regional industrial path development. This thesis empirically demonstrates that knowledge sourcing activities cause change in the regional innovation system, as new ideas are shared, and new knowledge is transferred and shared for innovation. The thesis further demonstrates

that system-level entrepreneurs can play an important role as initiators and facilitators of such knowledge sharing activities. Furthermore, the thesis provides novel research related to combinatorial knowledge dynamics within an emergent industry and finds that the phase of industrial development is recognised from intense knowledge sharing activities among a variety of actors. In relation to this process of combinatorial knowledge dynamics, the thesis suggests a more differentiated perspective on how knowledge is sourced and shared for innovation. It researches three knowledge sourcing mechanisms and finds that mechanisms that favour knowledge transfer are most commonly used, while interactive learning is less frequently used. The thesis find that labour mobility is the least used knowledge sourcing mechanism as it is the most comprehensive as well as the most expensive alternative. The findings in this thesis suggest that the nature and the geography of knowledge sourcing activity can influence the innovativeness of the initiating idea, who the actors are and how knowledge is sourced between and amongst the actors, and finally, also the expected outcome of such processes.

When it comes to geography, this thesis finds that the region is the overall most important geography for all knowledge sourcing mechanisms but also that there is a notable difference in the geographical patterns of knowledge sourcing activity. The thesis finds that knowledge transfer through monitoring is the mechanism that is the least geographically restricted in the examined case and that mobility is the mechanism that is the most bound to spatial proximity. This thesis also finds that thick and diversified RISs are the regional setting most favourable to fostering and growing innovativeness and that such regional settings are the contexts that are the most supportive to industrial new path creation. The thesis finally finds that thick and specialised RISs are mostly prone to supporting new regional industrial path development in the form of intra-path changes, while thin RISs is expected to be the geography least favourable to promote new industrial path development.

In sum, the thesis contributes to the literature on economic geography and the new regional industrial path development literature by presenting novel research that links the characteristics of firm entrepreneurs to the expected outcome of regional industrial path development. It further contributes by introducing system-level entrepreneurs and demonstrating their importance to new regional industrial path development as system expanders and system builders. Furthermore, it contributes to the research agenda by

identifying knowledge sourcing as a key mechanism to initiate and fuel new regional industrial path development, and, finally, it adds to our knowledge by demonstrating how regional settings can influence the initiation of new regional industrial development as well as the following process and its final outcome.

4.5. The need for further research

This thesis calls for further research in several areas that concern new regional industrial path development. In the following, three such areas are highlighted.

Firstly, the introduced typology of new entrepreneurial firms' expected contribution to path development outcomes should be further investigated. The thesis particularly invites empirical studies to investigate the usefulness of such a typology and to determine whether or not this typology can work as a helpful tool for tailoring regional policy and political initiatives that aim to promote certain types of regional path development. *Secondly*, the role of system-level entrepreneurs should be further researched both theoretically and empirically. In particular, this thesis invites papers to elaborate further on the interactive process between firm-level entrepreneurs and system-level entrepreneurs in new regional industrial path development and to determine how such interactions are either promoted or hampered by various regional settings. *Thirdly*, the thesis finds that additional research is needed to gain a better understanding of how the mechanism of combinatorial knowledge sourcing unfolds in various regional contexts and, further, to continue the research on how these dynamics influence the outcome of new path development in various regional settings.

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Regional industrial path development: The role of new entrepreneurial firms

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Abstract

Entrepreneurs play an important role in the evolutionary process of regional industries. As founders of new firms, entrepreneurs increase the supply side of the industrial economy, and by doing so, they challenge the incumbent firms to respond. From the perspective of evolutionary economics, understanding these dynamics of entrepreneurial triggers and industrial firm responds are important, as it sheds new light to our understanding of how regional industries evolve.
The entrepreneurship literature offers several classifications which are helpful in distinguishing between different types of entrepreneurs and firms. However, none of these classifications and typologies are suitable for explaining what effect new entrepreneurial firms may be expected to have on regional industries and their future development. This paper seeks to address this knowledge gap. Based on two dimensions, innovation novelty and entrepreneurial growth intention, the conceptual framework develops a typology of new entrepreneurial firms' expected effect on future regional industrial development. In doing so, the paper contributes to the field of evolutionary economic geography by introducing a new perspective on entrepreneurial firms' contribution to dynamic regional industrial path development.

Keywords: Regional development, Entrepreneurship, Path dependency, Typology, Innovation novelty, Growth intentions

Background

Evolutionary economics argue that economic development and growth take place as a result of an evolutionary process (Nelson, 2008; Nelson and Winter, 2009). As part of this process, new firms are introduced to the existing industrial structure, and during their life cycle, most new firms go through growth and decline before they eventually die (Ireland et al. 2009).

This paper argues that, in a capitalist economy, the overall level of regional economic performance results from aggregated decisions of firms. An industry is defined as a group of firms producing products that are close substitutes for one another (Porter, 1980) and regional industries consist of actors seeking to advance their interests based on bounded rationality (Simon, 1982) and in interaction with others (Scharpf, 1997). The result of these individual firm decisions are visible in overall regional industrial development.

Path dependence theory is increasingly used as a theoretical framework for analysing regional industrial development (Henning et al. 2013; Isaksen and Trippl, 2014). The

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theory argues that regional industrial development is a path dependent process, as today's regional industrial structure is heavily influenced by its historical legacy (Boschma and Frenken, 2006, p. 280:281). Path dependency theory argues that the way industrial structures, infrastructure and institutional frameworks appear today will favour some industry relevant choices over others (Martin and Sunley, 2006). Path dependency theory further argues that, once created, industrial paths may develop in two directions (Martin, 2010). The first direction is towards a limited extension of the pathway, while the other is a more dynamic development. While the limited extension of the industrial path is based on a situation of knowledge recirculation, the dynamic evolution of industrial paths is based on renewed regional knowledge and innovation.

New firms play an important role in industries' evolutionary processes. The new firm contributes to regional industrial path development in one of three ways. Either it contributes to reinforcing existing technologies and knowledge, to renewing the industry by bringing in new technology, networks or knowledge, or it contributes to regional industrial path creation by exploiting business opportunities new to the region and thereby introducing a potential new industry (Martin, 2010; Martin and Sunley, 2006; Tödtling and Trippl, 2013).

As creators of new ventures, entrepreneurs contribute significantly to this process of regional industrial evolution. However, although entrepreneurship literature seems to agree that context matters (Aldrich and Cliff, 2003; Aldrich and Fiol, 1994; Baumol, 1990; Dahl and Sorenson, 2009; M. Granovetter, 1985; Jack and Anderson, 2002; Petrakis and Kostis, 2014; Van de Ven, 1993), entrepreneurship researchers tend to view both the entrepreneurs and their new firm formations as decontextualised entities (Alsos et al. 2014). In this string of research, entrepreneurs seek to increase their chances of entrepreneurial success by optimising their new firm location (Liargovas and Daskalopoulou, 2011) and as so, entrepreneurs contribute to increased regional interaction and knowledge flow.

The entrepreneurship literature offers several classifications which are helpful in distinguishing between different types of entrepreneurs (Kirzner, 1973; Schumpeter, 1934 [2012]; Smith, 1967) and various forms of entrepreneurial ventures (Campbell and Carayannis, 2016; Kirchhoff, 1994; Westhead and Howorth, 2007), but none of these are suitable to explain their expected contribution to regional industrial path development. A mapping of the expected contribution of entrepreneurial firms to industrial path development is important for two main reasons. Firstly, the outcome of entrepreneurial activity seems to vary in terms of job creation (Henrekson and Johansson, 2010) and expected economic outcome (Alsos et al., 2014; Fritsch, 2011). A typology helpful in detecting the potential future impact of a new entrepreneurial firm on existing and new industrial paths is important as it would function as an early warning mechanism for the future of the regional industry. Secondly, such a typology would be helpful to politicians wishing to predict future regional development and tailor political strategies, policy instruments and infrastructure to support their desired growth trajectories.

The aim of this paper is to introduce such a typology of new entrepreneurial firms. Based on two dimensions, those of innovation novelty and entrepreneurial growth intention, the paper's conceptual framework identifies four types of entrepreneurial firms expected to contribute differently to regional industrial path evolution. In introducing this typology, the paper seeks to provide an answer to the following research question:

What common characteristics of new entrepreneurial firms support various regional industrial development paths?

The remainder of the paper is organised into five main sections: section two presents relevant theory within the field of entrepreneurship and path dependency, while section three introduces the two main variables which are important in identifying new entrepreneurial firms' expected contributions to the existing regional industrial structure. In section four, the new entrepreneurial firm typology is presented and in section five some important policy implications of the new firm typology are discussed. Finally, section six summarises and presents a short conclusion.

Theoretical framework

Entrepreneurship

Regional industries are complex systems, and according to Porter, they consist of a critical mass of related individual firms founded upon a variety of knowledge, competences, resources and technologies (Porter, 1980). It is in this context that entrepreneurs become important. As founders of new firms (Gartner, 1988), entrepreneurs increase the supply side of the regional economy and thereby create an incentive for existing firms to perform better (Fritsch, 2011; Porter, 1980). As such, entrepreneurs play a vital role in contributing to regional industrial development.

Firms are the key actors in regional industrial development as it is presented in this paper. As the majority of new firms are started by entrepreneurs, I begin the theoretical groundwork by looking at entrepreneurship theory and some of the existing classifications of entrepreneurs and firms. My main focus in this paper is to identify what determines the relative effect of these entrepreneurial firms on industrial development, and a natural starting point is the Schumpeterian and Kirznerian schools of entrepreneurship, as these schools introduce different definitions of entrepreneurship and therefore different analysis of how entrepreneurs contribute to regional development.

Schumpeterian entrepreneurs versus Kirznerian entrepreneurs

The first school of thought was founded by Joseph Schumpeter. In his book *The Theory of Economic Development*, first published in English in 1934, Schumpeter criticised neoclassical economics for being unable to explain economic change and development (Schumpeter, 1934 [2012], p. 62). Schumpeter argued that neoclassical economics illustrates the power of equilibrating forces in the economy, and thereby the economic tendency towards a state of 'circular flow' rather than economic development and growth (Schumpeter, 1934 [2012], p. 62). If economic development is to take place, he argues, a 'spontaneous and discontinuous change in the channels of the flow, disturbance of equilibrium, which forever alters and displaces the equilibrium state previously existing' is needed (Schumpeter, 1934 [2012], p. 64).

According to Schumpeter, such discontinuous change is a result of new combinations of existing resources and he defines development as either (a) the introduction of a new good; (b) the introduction of a new method of production; (c) the opening of a new market; (d) the conquest of a new source of supply of raw materials or half-manufactured goods or (e) the carrying out of the new organisation of any industry (Schumpeter, 1934 [2012], p. 66).

Defining development as a recombination of resources resulting in one of these five possibilities presupposes both a conductor and an arena. Schumpeter defines both when he writes: 'The carrying out of new combinations we call "enterprise", and the individuals whose function it is to carry them out we call "entrepreneurs"' (Schumpeter, 1934 [2012], p. 74).

According to Schumpeter, the role of entrepreneurs is crucial in creating economic development and growth. Entrepreneurs introduce radically new solutions to the marketplace, and in doing so they challenge 'old' solutions. As a consequence, old solutions need to be renewed in order to avoid destruction. Schumpeter called this process of increased competition creative destruction (Schumpeter, 1942) and he argued that economic development is a result of a continuous evolutionary process of creative destruction.

In his 1973 book, *Competition and Entrepreneurship*, Israel Kirzner challenged the Schumpeterian view of an entrepreneur. While Schumpeter describes the entrepreneur as the person causing creative destruction and radical changes, Kirzner describes the role of the entrepreneur as quite the opposite, namely as an equilibrating force. According to Kirzner, an entrepreneur is a person constantly searching the market for failure of coordination and therefore for potential gains from trade. According to the Kirznerian school of thought, the gaining of trade is visible as an above-equilibrium price and when such opportunities arise the entrepreneur enters the marketplace to exploit the observed business opportunities and collect the entrepreneurial profit. Kirzner describes the 'pure entrepreneur' and the 'entrepreneurial profit' in this way: The pure entrepreneur '*…proceeds by his alertness to discover and exploit situations in which he is able to sell for high prices that which he can buy for low prices. Pure entrepreneurial profit is the difference between the two sets of prices*' (Kirzner, 1973, p. 48).

As the calculation of 'above-equilibrium' prices is based on subjective price and cost analyses, the Kirznerian approach to entrepreneurship is highly subjectively orientated. If an entrepreneur exploits an opportunity, it is because (s)he considers the profit margin to be worth exploiting. Starting a new sports shop in one's neighbourhood could be a good entrepreneurial idea according to Kirzner. This is so even if the shop sells more or less the same items as other sports shops in the area. The central question is whether you act upon a subjective analysis of profit potential or not. If you do, and if you are right, the market entrance will provide entrepreneurial profit.

The Kirznerian definition of entrepreneurs as persons entering the market in order to exploit what (s)he believes will bring entrepreneurial profit contrasts with the Schumpeterian definition of an entrepreneur. According to Schumpeter, the person starting up a new sport shop would not automatically be considered an entrepreneur. In the Schumpeterian school of thought, the new firm owner would be considered an entrepreneur only if the sport shop launches an innovation radical enough to cause creative destruction.

Kirzner describes the difference between himself and Schumpeter in this way: 'For Schumpeter the entrepreneur is the disruptive, disequilibrating force that dislodges the market from the somnolence of equilibrium; for us the entrepreneur is the equilibrating force whose activity responds to the existing tensions and provides those corrections for which the unexploited opportunities have been crying out' (Kirzner, 1973, p. 127).

Based on this quote from Kirzner, it could be argued that Schumpeter promotes a 'technology push' dominated view of entrepreneurship while Kirzner, in contrast, promotes a 'market pull' perspective. According to Schumpeter, the entrepreneur takes a proactive stand and creates opportunities by introducing path breaking innovations, while the entrepreneur in a Kirznerian tradition responds to opportunities presented to them.

Even if the two definitions of entrepreneurs and their role in society are quite different, the Schumpeterian and Kirznerian forms of entrepreneurship may coexist. This has been repeatedly emphasised by Kirzner (1973, p. 149), and the coexistence of the two types of entrepreneurs is also emphasised in this paper. As both types of entrepreneur fulfil different roles within the economy, both types of entrepreneurs are important contributors to regional industrial development.

Other classifications of entrepreneurs

While Schumpeter and Kirzner present different analyses of what an entrepreneur is and how entrepreneurs contribute to economic development, several attempts have also been made to categorise entrepreneurs.

A central theme in early entrepreneurial research was to focus on the motivations and background characteristics of entrepreneurs. The early work was inspired by Norman Smith (Smith, 1967) and his presentation of the Craftsman-Opportunist dichotomy (see for instance (Davidsson, 1988; Lorraine and Dussault, 1987; Smith and Miner, 1983)). The Craftsman-Opportunist dichotomy profiles the Craftsman entrepreneur as coming from a blue-collar background and being motivated by personal autonomy and the Opportunist entrepreneur as well educated and experienced, seeking to build a successful organisation and achieve financial gains. Smith concludes that this difference in entrepreneurial motivation results in contrasting potential for growth in terms of job generation and wealth creation (Smith, 1967).

Another categorisation within the field of entrepreneurship is the theory of Dynamic Capitalism put forward by Bruce A. Kirchhoff. In his 1994 book, he argues that firm growth and the firm innovation rate will determine the extent of the creative destruction effect the firm has on the economy as a whole. Kirchhoff distinguishes four categories of firms contributing differently to the development of a capitalist economy. Economic Core firms have a low growth rate and a low innovation rate, while Ambitious firms have a high growth rate and a low innovation rate. Constrained Growth firms have a high innovation rate and a low business growth rate and, finally, Glamorous firms have a high business innovation rate and a high business growth rate.

The entrepreneurial ambition to build a successful organisation and achieve financial gains has, more recently, been studied closely within the field of Ambitious entrepreneurship (Stam et al., 2012). An ambitious entrepreneur emphasises the aim of creating value beyond self-sufficiency and ambitious entrepreneurs are motivated by the rewards of entrepreneurship, in either its status or its outcome (Stam et al., 2012, p. 24). Analysing ambitious entrepreneurs, Gundry and Welch (2001) found a causal link between high commitment to entrepreneurial ambitions and realised success in a number of dimensions for female entrepreneurs in the USA (Stam et al., 2012, p. 25).

Two of the later contributions within research on entrepreneurial contributions to regional growth is presented by Nightingale and Coad (2014) and by Campbell and

Carayannis (2016). In their paper, Nightingale and Coad argue that the contribution of entrepreneurial start-ups to the economy is multi-faceted. A large group of entrepreneurial new firms have limited impact on economic growth, while a rather small group of new entrepreneurial firms act as drivers of economic progress. As the contribution to the economy varies widely amongst start-ups, Nightingale and Coad call for a more nuanced categorisation of the term 'entrepreneurial firms'. They suggest adding the label 'muppets', as a contrast to the well-known 'gazelles'. Muppets and gazelles symbolise two extremes of entrepreneurial firms divided by their economic impact. Muppets are poor performing firms with low ambitions and low innovation novelty, while gazelles represent the very small group of entrepreneurial high growth firms making a huge impact on local economies as outstanding job creators (Henrekson and Johannson, 2010). Finally, Campbell and Carayannis (2016) introduce academic firms as an alternative to commercial firms. The authors argue that the main difference between the two categories of firms is that the first is focused on maximizing knowledge, while the latter focuses on maximizing profit.

Path dependent regional industrial evolution

From its introduction in the 1980s and 90s, path dependence theory has been increasingly important in the field of economic geography. The core of the theory is that decisions economic actors face today are affected by decisions made in the past and that history therefore favours some decisions over others (See for instance (Martin, 2010; Martin and Sunley, 2006)).

Within the field of economic geography, the theory of path dependence has shifted focus in recent years. From being mainly concerned with the development of existing pathways and lock-in situations, increasing focus has been placed upon the renewal and creation of regional industrial paths (Coenen et al. 2015; Dawley, 2014; Isaksen and Trippl, 2014; Martin, 2010; Martin and Sunley, 2006). According to Martin (2010, pp. 20–21), the evolution of regional pathways could be described as a process with four phases. *The first phase* is a preformation phase, where the creation of new paths is based on historically gained knowledge, resources and experiences. By introducing this phase, Martin extends the understanding of path creation from the original versions presented by David (1985) and Arthur (1988), who argue that paths are created by chance or historical accident. In the *second phase* new regional paths are created, while *phase three* is the early stage of path development resulting from increasing returns and network externalities. Passing through these first developing phases, the path will follow one of two possible trajectories in *phase four*. The first option is movement to a stable state resulting from a reinforcement strategy, while the second option is a dynamic path developing process resulting from a continuing process of improvement and renewals. As industries consist of firms producing close substitutes for one another (Porter, 1980), the processes of regional industrial path development result from aggregated firm decisions, including those of newly introduced firms. The model of path dependent local industrial evolution introduced by Martin (2010) is presented in Fig. 1.

From the model of regional path dependence we learn that regional industrial paths are both created and formed by structural constraints. The creation of a new regional industry represents the most comprehensive change to a regional economy. More

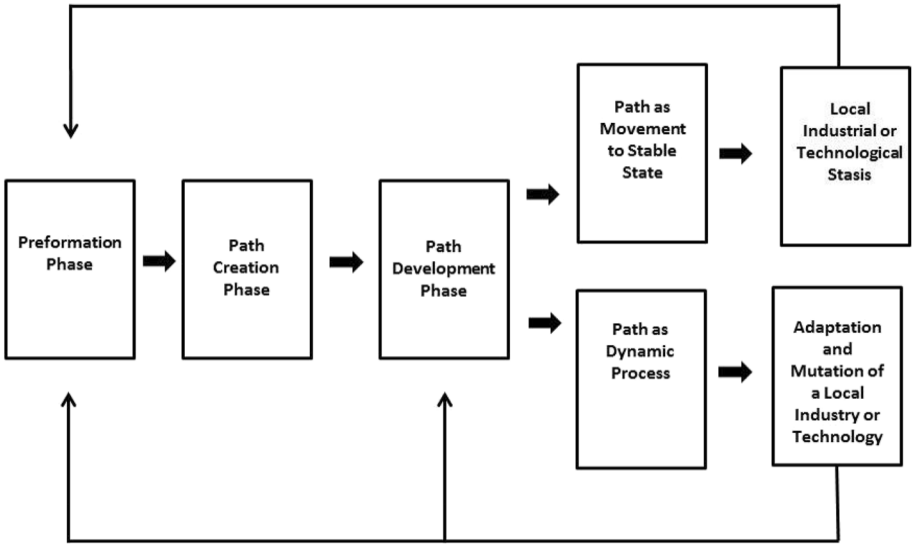

Fig. 1 Regional path dependence model. Source: Martin 2010, 21

recent literature argues that new industrial paths could result from two possible sources of ideas. Firstly, regionally new firms could be founded upon ideas new to the world, or secondly, regionally new firms could be founded upon ideas known to the world but new to the region (Tödtling and Trippl, 2013). The first alternative results from a radical new innovation as we know it from Schumpeter, while the second alternative is more in line with Kirznerian entrepreneurship, known in the literature as either the possible start of a regional path transplantation (Martin and Sunley, 2006) or a regional path formation (Tödtling and Trippl, 2013). Path transplantation occurs when an existing industry settles in a region for the first time.

The regional path dependence approach argues that, once created, a new industry could take one of two directions. Either it could develop towards a stable state situation or the industry could develop dynamically. A regional path development leading towards a stable state situation results from reinforcement. An industry where firms lean on previous technology, structures, networks and knowledge developed over time, will gradually cement existing solutions and the industry will gradually evolve towards stasis and decline. If not reinforced, Martin (2010) argues that the path will develop more dynamically. Recent literature argues that a dynamic path evolution could follow two different dynamics. The existing path may be either extended or renewed (Boschma and Frenken, 2012). Path extension results from incremental product and process innovations based on existing knowledge (more of the same) and, without new knowledge from outside, the innovation potential will gradually decrease until the industry faces exhaustion (Isaksen and Trippl, 2014). Path renewal takes place when existing local firms branch into different but related activities and sectors (Boschma and Frenken, 2012). Which type of renewal occurs is influenced by the historically formed regional specialisations and by the dominant regional knowledge bases.

To sum up, the theory of path dependence outlines two stages of regional path evolution. In the first stage, new industries are born, as a result of either a path creation or a path formation process, and in the second stage industries develop following a pathway of reinforcement or renewal.

The entrepreneurial context

As argued by the path dependency theory, decisions made in the past influence the possibilities, resources and knowledge available in a region today. Entrepreneurs evaluate these regional possibilities and constraints, and find them more or less attractive to their entrepreneurial idea. The regional innovation system (RIS) approach (Asheim and Isaksen, 2002) argues that regional actors belong to one of two possible sub systems, and that these systems are embodied in a framework of formal and informal institutions (Asheim and Isaksen, 2002; Isaksen and Trippl, 2016). The RIS approach further argues that regions are differently conditioned to foster and promote innovation as RISs vary in their institutional and organisational support. Best conditioned for innovations are entrepreneurs and firms located in organisational thick and diversified RISs recognised from a large number of both related and unrelated actors in both sub systems, and from here the regional organisational support for innovation declines as the RIS become more organisationally specialised and less organisationally thick (Isaksen, 2014; Isaksen and Trippl, 2016; Tödtling and Trippl, 2005).

As regions differ in their support of innovation, an important question then arises as to whether entrepreneurs are embedded actors rooted in their local milieu, or if they are to be considered more as nomads searching to locate their new venture in the most supportive RIS. The literature seems to differ in this question of location determinacy. While parts of the entrepreneurship literature argue that entrepreneurs are to be considered as embedded actors which hardly ever consider localisation outside their own local community (Dahl and Sorenson, 2009; Fritsch, 2011), other parts of the literature argue differently when stating that entrepreneurs locate their business in regional contexts favouring the success of their new venture (Liargovas and Daskalopoulou, 2011).

Despite some different views on location determinants, the entrepreneurship literature agrees that regional context affects entrepreneurship in several ways. Some examples in this respect are that regions can be more or less supportive to opportunity entrepreneurship (Petrakis and Kostis, 2014), more or less supportive to financing start-ups (Liargovas and Daskalopoulou, 2011), support technology transfer, global innovation relations and collective social capital differently by innovative and forward leaning ICT solutions (Liargovas and Daskalopoulou, 2011), they can vary in their policy support to entrepreneurship, in their knowledge infrastructure and their industrial structure (Isaksen, 2014; Isaksen and Trippl, 2016; Tödtling and Trippl, 2005), and they can vary in their cultural and embedded institutional support (Asheim and Isaksen, 2002).

To sum up, we argue that regions are unevenly conditioned to foster and support entrepreneurship. Further, we argue that most often organisationally thick regions are better conditioned to foster innovation than organisationally thin regions as the number and the variety of actors are higher, and that regions hosting an organisational thick and diversified regional innovation system holds the best conditions for radical innovative entrepreneurs as the knowledge infrastructure is both thick and diverse (Asheim and Isaksen, 2002; Castaldi et al. 2015; Glaeser et al. 1991; Henderson, 1997; Isaksen, 2014; Isaksen and Trippl, 2016; Tödtling and Trippl, 2005).

Characteristics of new firms supporting various industrial development paths

So far, we have argued that entrepreneurs contribute to regional industrial development by introducing new firms, that industries consist of firms producing products that are close substitutes for one another and finally that industries tend to develop through certain pathways affected by history and their unique regional innovation system.

The consequence of these arguments is that every new entrepreneurial firm contributes to develop the industry they enter, and that this contribution can take one of three possible directions. The alternatives are (a) to extend the industry, (b) to renew the industry and (c) to bring in a potentially new industry to the region. In this section, we discuss two characteristics important to identify the expected effect of the new entrepreneurial firm to the existing industry, namely entrepreneurial growth intentions, and innovation novelty. A relevant question is why these two? Why not include other important micro variables like available resources as finance (Liargovas and Daskalopoulou, 2011) or knowledge (Komninos, 2009), or possible macro effects like entrance barriers (Porter, 1980) or industry life cycle stage (Phaal et al. 2011)? First of all, these are certainly important variables in order to predict future success of the business, and therefore also important indicators to predict possible effects on future regional industrial development. However, so is network (Burt, 2004; M. Granovetter, 1985; M. S. Granovetter, 1973; Martin and Moodysson, 2011), the socio-economic background of the entrepreneur (Dahl and Sorenson, 2009), the support of public policy instruments (Uzunidis et al. 2014) and many other factors. So, why are these not included? The answer is that the two carefully chosen dimensions (fundamenta) are to be considered as reductions (Marradi, 1990) with the intent to represent a broad set of variables. Growth intention is a reduction of the subjective evaluation of the chances to achieve entrepreneurial success, and innovation novelty is a reduction of the potential embedded in the business idea itself. In the following we present the chosen dimensions more closely.

Growth intention

Firm growth is an important driver of industrial development as it increases competition (Fritsch, 2011; Martin, 2010), provides new jobs (Henrekson and Johansson, 2010) initiates innovation (Fritsch, 2011; Martin, 2010; Stam et al., 2012) and is necessary in order to create a creative destruction process (Kirchhoff, 1994; Schumpeter, 1934 [2012]). Firm growth measures new value creation (Stam et al., 2012), and as we have seen from the Craftsman-Opportunist dichotomy (Smith, 1967), the Dynamic Capitalism typology (Kirchhoff, 1994) and the theory of Ambitious Entrepreneurship (Stam et al., 2012), new value creation is key to economic development.

However, not all entrepreneurs want their firms to grow. Edith Penrose, pointed to this fact in her classic 1959 book, writing 'There are many businessmen, and very efficient ones too, who are not trying always to make more profit if to do so would involve them in increased effort, risk, or investment' (Penrose, 2013, p. 31). As Penrose suggests, firm growth might have undesirable consequences for the entrepreneur and this observation has been confirmed also by later research. For instance, Wiklund et al. (2003) found that firm growth could be undesirable as it affects job satisfaction, involvement and job atmosphere.

If firm growth is an important driver for industrial development (Kirchhoff, 1994; Martin, 2010; Schumpeter, 1934 [2012]) and not all entrepreneurs want their firm to grow in the future (Penrose, 2013; Wiklund et al., 2003), which characteristics are essential to future growth? Penrose (2013) points to one such fundamental characteristic when arguing: '… and so long as a firm is dominated by men who are not ambitious always to make profits it is unlikely that the firm will grow very large' (Penrose, 2013, p. 32). Ambition and intentions being closely related, this point of view is supported by (Ajzen, 1991). Ajzen highlights the importance of intentions when explaining different outcomes. In his well-known theory of planned behaviour, he defines intention as: 'how much of an effort they are planning to exert, in order to perform the behaviour' (Ajzen, 1991, p. 181), and he further describes the causality between intention and behaviour in this way: '… as a general rule, the stronger the intention to engage in a behaviour, the more likely should be its performance' (Ajzen, 1991, p. 181). The finding that growth intention is (close to) a necessity in order to achieve actual firm growth is also supported by later research (Kolvereid and Bullvag, 1996; Miner, 1990; Miner et al. 1989; Stam et al., 2012; Wiklund and Shepherd, 2003). Based on these arguments, we sum up that growth intentions vary, that growth intentions are (close to) a necessity for firm growth and that the stronger the growth intention, the more likely the firm is to experience growth.

Herbert Simon (1986), states that 'people have reasons for what they do', and further, that their decisions are 'reasonable in the light of the available knowledge and means of computation' (Simon, 1986, p. 8210/8211). This procedural approach to rationality indicates that there is a link between what is available to a person, and the outcome of his/her reasoning. If this is correct, one would expect available resources and contextual conditions to influence the reasoning of entrepreneurs. Defining growth intentions as being the entrepreneur's aspirations for future actual growth, the previous argument would suggest that individual and environmental constraints will influence the reasoning of entrepreneurs when evaluating their possibility to achieve actual growth in the future. The findings of Dutta and Thornhill (2008) support this argument of correlation. Their findings indicate that shifts in perception of competitive conditions over time, lead entrepreneurs to modify their growth intentions accordingly. Furthermore, research also indicates differences in growth intentions from socio-demographic characteristics such as, gender, age (Busenitz and Lau, 2001) and education level (Kolvereid and Bullvag, 1996). Moreover, Busenitz and Lau (2001) found that entrepreneurial commitment, the entrepreneurial need for achievement and that the social environment of the entrepreneur like market conditions, social network and business experiences, had a direct impact on growth intentions.

Based on the presented reasoning and empirical evidence, we argue that entrepreneurial growth intentions (at least to some extent) include a subjective understanding of individual and environmental constraints and possibilities available to the entrepreneur. As so, it could serve as a fundamenta suitable for a typology of entrepreneurial firms which aims to identify expected effects of their entrance to future industrial development.

Innovation novelty

Based on the Path Dependency theory, a second firm characteristic important in determining the entrepreneurial contribution to regional industrial path development is the

innovation novelty of the entrepreneurial firm. According to Tödtling and Trippl (2013), new path formation represents innovation new to the region (not new to the world), while path creation in new industries represents innovation new to the world. The distinction between regional path formation in established industries and new industrial path creation is the degree of innovation novelty, where the question 'new to whom?' is essential.

Following the rather exclusive definition of innovation given by Schumpeter (1934 [2012]), the concept of innovation has become multi-faceted in later years. Based on the degree of novelty, innovation is commonly classified as either radical or incremental. Radical innovation is understood as a totally new product, process, marketing method or organisational method, in line with the Schumpeterian definition (Schumpeter, 1934 [2012]), while an incremental innovation is understood as a step-by-step improvement of existing solutions (Fagerberg et al. 2005). Innovation novelty is also central to The Oslo Manual for collecting and interpreting data about firms' innovation performance, where the degree of novelty is divided into geographically separated groups. According to The Oslo Manual, innovation can be classified as either new to the firm, new to the market or new to the world (OECD/Eurostat 2005, p. 57).

The theory of path dependency further argues that various novelties in innovation supports various path developments. Firstly, the theory argues that new firms without innovation support path reinforcement and thereby contribute to increasing rigidification of associated structures, networks and knowledge of firms (Martin, 2010). Secondly, the theory of path dependency argues that incremental innovation is needed in order to secure both path extension and path renewal (Isaksen and Trippl, 2014). While path extension results from incremental innovation based on the combination of existing knowledge to create more of the same, new knowledge is needed for the incremental innovation to lead to path renewal. Thirdly, based on the degree of innovation novelty, the theory states that innovation new to the region could result in new path formation (Tödtling and Trippl, 2013) and that radical innovations could form industries new to the world (Kirchhoff, 1994; Schumpeter, 1934 [2012]; Tödtling and Trippl, 2013).

This line of argument concludes that the degree of innovation novelty influences future regional industrial paths. Firstly, if industrial paths are to be renewed, new knowledge has to be created in the region or new knowledge has to be imported from outside and implemented in existing industry (Tödtling and Trippl, 2013). Secondly, if new regional industrial paths are to be created, a minimum level of innovation novelty is needed at a regional level (Tödtling and Trippl, 2013). Finally, if innovation is incremental and comes only from the recirculation of existing knowledge, the innovation height will gradually decrease and the industrial path will eventually face path exhaustion (Isaksen and Trippl, 2014).

Results and discussion

Towards an entrepreneurial firm typology

This paper has argued that both entrepreneurial growth intentions and innovation novelty are characteristics important for identifying the potential future industrial path contribution of new entrepreneurial firms. In Fig. 2, the two characteristics are introduced within the framework of a 2×2 matrix. The matrix outlines four different categories of entrepreneurial firms which hold different combinations of the two characteristics.

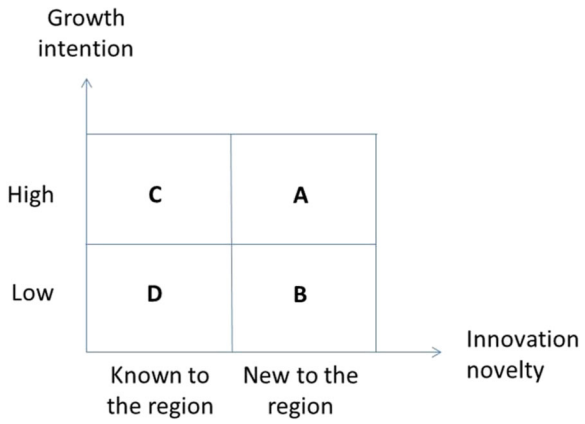

Fig. 2 Combinations of innovation novelty and growth intentions

By introducing an innovation new to the region, entrepreneurs which found type A firms develops, or imports, new knowledge, and introduces novel solutions that might have the potential to initiate a new industry for the region (Kirchhoff, 1994; Phaal et al., 2011; Schumpeter, 1934 [2012]). However, industries are not formed by one single firm, and for other firms to follow, the virgin firm has to demonstrate sufficient profitability and/or growth. The entrepreneur behind firm A has high intent to grow the firm, and, as argued previously, growth intention is seen as a necessity for firm growth (Kolvereid and Bullvag, 1996; Miner, 1990; Miner et al., 1989; Stam et al., 2012; Wiklund and Shepherd, 2003). The consequence is that firm type A possesses the combination needed to be a potential path creating firm within the region. Remember that entrepreneurs of type A firms introduce innovations novel to the region, but not necessarily innovations new to the world (Tödtling and Trippl, 2013). As so, type A firm entrepreneurs could be both entrepreneurs importing business ideas from other regions, and it could be entrepreneurs launching ideas novel to the world. For regions to foster innovations new to the world, the literature argues that thick and diversified RISs are the most suitable environments as they host a large number of firms, knowledge generators like universities and R&D organisations, and a large amount of policy support organisations, non-profit organisations and finance organisations. Being mostly urban and metropolitan areas, thick RISs favour unrelated knowledge linkages and externalities spurring from a variety of sectors which mutually influences each other and triggers new ideas and innovation. Tesla entrepreneur Elton Musk might serve as an example of a type A entrepreneur introducing innovations new to the world, while the boat building entrepreneur Herbert Waarum might serve as an example of the second variant of type A firm entrepreneurs. Herbert Waarum, was the pioneering entrepreneur to introduce fibreglass as a building material, and as so initiated the industry of fibreglass boats in Arendal, Norway (Isaksen, 2016).

Firm type B holds the same level of innovation novelty, but is distinguished from firm A as the entrepreneur holds a significantly lower intent to grow. By introducing a regional new innovation, entrepreneurs introducing type B firms develop, or introduce knowledge new to the region. However, the lack of entrepreneurial growth intention limits the growth potential of the new firm. As the entrepreneurs holds low growth intentions the firm is not likely to demonstrate attractive profit rates, and is therefore not

likely to attract the 'swarm' of followers needed to create a new industry. Firm B is therefore expected to contribute to regional path renewal through the introduction of new solutions, but are not expected to contribute to regional new path creation. As highly innovative, entrepreneurs forming type B ventures based on innovation new to the world would benefit from the knowledge sharing environments provided in thick regions. Thick regions are mostly found in urban economies where the access to unrelated and academic knowledge is high. Research-driven entrepreneurial firms aiming to fulfil a mission or a perceived obligation rather than to maximize profit could serve as examples of firm B entrepreneurs.

Firm type C is another moderate type of firm, as it lacks innovation novelty. As the firm does not import new knowledge from outside, its innovation is built upon the recycling of knowledge already known to the region, and as there is nothing new, the recombination of knowledge has low innovation potential. Even so, firms founded by entrepreneurs with high intent to grow will do their utmost to challenge existing firms and win market share, and will therefore act as a driver of innovation for others and, as a consequence, other firms might be forced to develop new knowledge of their own or to create knowledge pipelines outside the region. Based on this, firm type C can potentially stimulate path renewal as an indirect effect. Entrepreneurs introducing type C firms will not be focussed towards exploiting the possibilities of urban economies. Less diverse regions would fit these entrepreneurs more as long as the marked potential is high. Entrepreneurs starting up local variants of privately owned chain-stores could serve as examples of this type of firms. Their motivation is increased turnover from increased market shares rather than growth through innovation. Privately owned petrol stations could serve as an example here.

Firm type D is the least challenging entrepreneurial firm. Firm D scores low on entrepreneurial growth intensions and also on innovation novelty. As such, firm D innovates by introducing new combinations of already regionally known knowledge. The lack of both innovation novelty and entrepreneurial growth intentions leads to a process of knowledge recycling which is expected to have relatively limited impact outside the firm. Firm D thereby contributes to industrial path extension, a situation which, if not renewed, will gradually reduce into a stable state situation resulting in industrial path exhaustion. Entrepreneurs who introduce type D firms are to be found in all regions, also regions hosting an organisational thin RIS. Actually, thin RISs are dominated by this type of firms as they provide poor conditions for innovation (Isaksen, 2014). Entrepreneurs behind firms of type D are not ambitious and mainly focused on being self-sufficient. Examples of these types of entrepreneurs are most family-owned microbusinesses, farms, craftsmen's and single-person consultancy firms.

In Fig. 3, the path development firm typology is visualised.

To secure healthy regional development, all types of new firms have to be represented. The path extending firms (type D) are recognised as the supporting beam of regional industry, in which imitation and Kirznerian entrepreneurship play an important role. These types of firms have two effects on regional industrial development. On the one hand, these firms are needed to exploit the potential of local knowledge and to secure a sustainable balance between regional buyers and suppliers, but on the other hand this type of firm also contributes to cementing existing technology and processes. Possible path extenders are not expected to increase the relative competitive strength

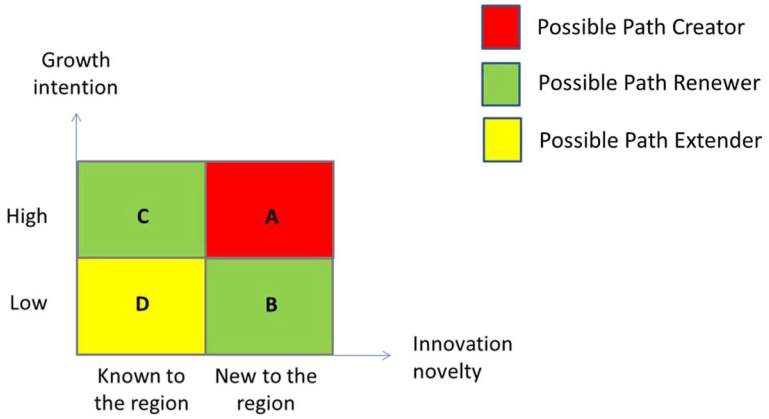

Fig. 3 The path development firm typology

of the region, but their main purpose is to secure low prices and stable and effective regional support based on existing knowledge.

In order to improve the competitive advantage of the region, industrial paths have to be regularly renewed. Path renewal involves the refilling of new knowledge, which is important for existing industries to branch into related activities and thereby expand the regional innovation potential. This mutation process then becomes industry driven, challenged by new firms propelled by individual entrepreneurial growth intentions and regional innovation novelty.

Finally, regions benefit from a critical mass of possible path creators (Schumpeter, 1934 [2012]). These types of new firms challenge the existing regional industrial structure as they introduce regionally new solutions paired with an intense will to succeed. Possible path creators possess two strong weapons which could both be beneficial to the region in their struggle to gain competitive advantages.

Policy implications

In the previous section, I argued that the four types of new firms have different influences on existing industrial paths and, further, that all four types of new firms are important in order to secure dynamic regional industrial development. From this, it follows that stimulation of new firm formation is a key task in regional industrial policy. An important question in that setting is what types of policy instruments are suitable for stimulating various types of entrepreneurs? In this section, I present some answers to this question. The structure of the discussion is based on the various types of entrepreneurial firms, from D to A.

Firm type D is the least radical of the four types of new entrepreneurial firms and their main contribution to regional development is to lower the price level and to maintain a stable supply of goods and services. As these factors are important in providing a high quality of life, regions would benefit from having a high number of potential entrepreneurs willing to act on potential gains from trade. The main purpose of policy instruments aiming to increase the numbers of type D entrepreneurs would therefore be to lower entrepreneurial barriers and to seek to build a supportive entrepreneurial culture. Even if they are not sufficient (Davidsson and Wiklund, 1997), we know that supporting institutions and a well-functioning financial system are important

building blocks in a supportive entrepreneurial culture (Acs et al. 2008; Liargovas and Daskalopoulou, 2011).

Firm type C and type B support regional path renewal either indirectly (firm C) or directly (firm B). As argued previously, the renewal of industrial paths requires either priming of new knowledge from outside or new combinations of regional related knowledge leading to path branching and, regardless of the renewal process motivation, industrial actors therefore need to connect to related sources of knowledge inside and outside the region (Isaksen and Trippl, 2014). In order to stimulate new firms which contribute to possible path renewal, regions should tailor their policy instruments towards the encouragement of intra- and inter-regional interaction in early stage activities. Such interaction should include both direct interaction through cooperation, mobility of labour and monitoring of firms and entrepreneurs (Martin and Moodysson, 2011).

In order to be a possible path creating firm (firm A), the new entrepreneurial firm needs to have a combination of regionally new knowledge and the entrepreneur needs to possess high intentions to grow. I have previously argued that a rich variety of actors within both RIS sub systems will fuel radical innovations (Boschma and Frenken, 2012; Fritsch, 2011; Isaksen and Trippl, 2016), but also that a new regional industry path could result from path formation in established industries (Tödtling and Trippl, 2013). Several political instruments could be important to stimulate the number of firm A start-ups. Firstly, the region should create favourable conditions for an improved relationship between R&D milieus, local entrepreneurs and early stage firms. This is important as the R&D knowledge tends to become more dominant as the degree of novelty increases (Asheim, 2007; Asheim and Coenen, 2005; Isaksen and Karlsen, 2012). Furthermore, in order to stimulate firms paving the way for industry transplantation, regions should (again) focus on inter-regional cooperation, movement of skilled labour and monitoring of actors from outside (Martin and Moodysson, 2011). However, as an industry is defined as a group of firms producing products that are close substitutes for one another (Porter, 1980), more than one firm needs to settle in the region in order to create an industry. A possible approach to encouraging more start-ups within the same industry could be to focus on policy instruments targeted at stimulating cluster growth. An important precondition for such policy instruments is, however, that there is institutional support to use these kinds of instruments within the economy (Hall and Soskice, 2001). We will not go into the field of institutional economics here, other than to touch upon the fact that the policy dimension in clusters is controversial in some economies while it is widely used and accepted in others.

From the above we can extract three main areas of importance for policy instruments. First of all, as regions benefit from low prices and a stable supply of goods and services, policy should contribute to lowering general entrepreneurial barriers and seek to support a positive entrepreneurial culture in the region. Secondly, as the renewal of industries and industrial path transplantation depend partly on new knowledge from inter-regional contact, regions should encourage and support initiatives of that kind and perhaps also initiate such initiatives themselves on behalf of regional firms and industries. Thirdly, in order to increase the influence of R&D knowledge, regions should encourage a close relationship between local firms and R&D milieus, as well as seek to stimulate diverse knowledge sharing activities between unrelated actors including potential entrepreneurs, early start-ups and established firms.

Conclusions

This paper builds on the capitalistic economic assumption that private firms, and therefore entrepreneurs, play an important role as drivers of economic growth and development. It further acknowledges that industries consist of firms producing products that are close substitutes for one another and that regional industries follow an evolutionary process from birth to death or transformation and renewal.

In this paper, I have argued that entrepreneurial new firms influence the future industrial development of the region in different ways. My main argument has been that new firms contribute to either regional industrial path extension, regional industrial path renewal or regional new path creation, and I have argued that innovation novelty and entrepreneurial growth intentions are significant firm characteristics for predicting the potential firm specific contribution to regional industrial path development.

Based on the two dimensions of entrepreneurial growth intentions and innovation novelty, I have developed a typology of new entrepreneurial firms classified by their possible path development contribution. The paper argues that possible path extending entrepreneurial firms (firm type D) can be recognised by their low innovation novelty and low entrepreneurial growth intentions, and that possible path renewing entrepreneurial firms (firm type C and firm type B) have an uneven score on the two variables, innovation novelty and entrepreneurial growth intention. Finally, the paper has argued that firms with a combination of regionally new innovation and high growth intentions from its entrepreneur (firm type A) are firms that could potentially form new industrial paths in the region.

Dynamic industrial developments in regions involve several important factors. First of all a sufficient number of competing firms are needed in order to secure low prices and stable supply (Kirzner, 1973; Schumpeter, 1934 [2012]), and secondly an industry needs a constant refill of new knowledge from outside in order to maintain its competitiveness with other regions (Martin, 2010). If it is not renewed, innovation potential will gradually decrease and the industry will face decline and finally exhaustion (Martin, 2010; Martin and Sunley, 2006). Dynamic regions need new industries to arise (Martin, 2010). New industries are important to secure long-term employment and knowledge refill in an evolutionary industrial process. From this evolutionary perspective, this paper has stressed the fact that all four types of new entrepreneurial firms are important in securing a dynamic industrial path evolution. An adequate number of type D firms are necessary to maintain low prices and stable supplies, while a significant number of type C firms are important as they create innovation pressure on existing firms based on increased competition. Firm B also creates this sort of innovation pressure, even if firm B does it somewhat more directly. By introducing new knowledge to the region firm B acts like a lighthouse for existing industries, but due to the lack of growth intentions the light from firm B is not very strong. As the entrepreneur has low growth intentions, type B firms are not likely to demonstrate very high profitability from this new knowledge, and therefore they are not expected to attract the 'swarm' necessary to create a new industry. Firm type A, however, has both high growth intentions and innovation novelty at a regional level. The paper argues that this combination is needed in order to be a possible new path creator in the region. However, industries are not easily formed and, more importantly, the combination of high ambitions and innovation novelty is no guarantee of commercial success.

As new firm entries influence future industrial path development in various ways, the question of how regions can stimulate the start-up rate of various types of firms becomes important. In this paper, I have identified three important areas of policy support, namely building a supporting entrepreneurial culture in the region, encouraging early stage firms and entrepreneurs to inter-regional knowledge transfer and seeking to increase R&D intensity and commercialisation from increased collaboration amongst R&D intensive milieus and firms dominated by other types of knowledge.

The path development entrepreneurial firm typology introduced in this paper is important for two main reasons. Firstly, a typology is helpful in analysing the future impact of a new firm on existing industrial paths, which is important as an early warning mechanism to predict the future quality of the regional industry. Secondly, such a typology will be helpful for politicians tailoring political strategies, policy instruments and infrastructure to support various future regional industry trajectories.

Future research work should look more closely at identifying the relative share of entrepreneurs in competitive regions when it comes to industrial path extension, path renewal and path creation, and also investigate how context affects this relative share of entrepreneurs. This perspective also invites a more conceptual debate concerning regional innovation systems. A central theme in such a debate should be whether or not regions should focus on building innovation systems centred on a specific type of firm.

Methods

This article is a conceptual contribution and does not include any empirical evidence.

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Availability of data and materials
The paper does not include any empirical evidence.

Competing interests
The author has no conflicts of interest to declare.

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Article II

Entrepreneurial Innovativeness and Growth Ambitions in Thick vs. Thin Regional Innovation Systems

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Research in economic geography has paid increasing attention to regional innovation systems (RISs) as a potential vehicle for growth and development. Yet despite an increasing amount of research studying RISs in particular and economic regions in general, we have limited knowledge about their influence on entrepreneurs and entrepreneurship. We respond to this knowledge gap and study if entrepreneurs' localization in thick vs. thin RISs affects their innovativeness and growth ambitions. Thick RISs are predominately urbanized spaces that include organizations of higher-level education, R&D intensive milieus, and an ample industry sector, while thin RISs to a lesser degree encompass these features. Empirically, we analyse 870-917 entrepreneurial firms in Agder of Southern Norway. Based on trade and labour markets, as defined by the EU's classification of local administrative units (LAU1), we identify two thick and six thin RISs in Agder. Econometric analyses show that entrepreneurs located in thick RISs are more innovative than entrepreneurs located in thin RISs, but there are no significant differences concerning entrepreneurs' growth ambitions. In light of our findings, we discuss the potential agency role played by entrepreneurial firms at a micro level on path dependent features of RISs at a macro level.

Key words: Regional innovation systems (RISs), entrepreneurship, innovation, growth ambitions, spillover, robust ordinal logistic regression, bootstrapping, coarsened exact matching (CEM)

Introduction

In an increasingly competitive world, the regional ability to offer innovative and economically viable products and services in the marketplace is crucial for growth and development for both individual firms and the society at large. Following this line of reasoning, the regional innovation system (RIS) approach emphasises that innovation and economic growth is stimulated by interactive processes between industry actors and knowledge-intensive organisations like universities and R&D-organisations that are geographically proximate to each other (Asheim and Isaksen 2002). Scholars argue that RISs are differently conditioned to foster and facilitate innovation and economically viable products at the marketplace (Asheim and Gertler 2005, Tödtling and Trippl 2013), and they suggest to make a distinction between so-called thick vs. thin RISs (Isaksen and Trippl 2016). Thick RISs are predominately urbanized spaces that include organizations of higher-level education, R&D intensive milieus, and an ample industry sector (ibid.), while thin RISs to a lesser degree encompass these features (Karlsen 2013).

The focus of this paper is to examine if entrepreneurs' localisation in thick vs. thin RISs influences their innovativeness and growth ambitions. Schumpeter (1934) pioneered the research fields of entrepreneurship and innovation by explaining how entrepreneurs play an important role as catalysts for innovations in the society. Later studies have likewise examined how entrepreneurial micro-level characteristics influence innovation performance along with other outcome indicators such as enterprise growth and development (e.g. Stuart 2000, Baum, Calabrese, and Silverman 2000, Owen-Smith and Powell 2004). However, albeit an increasing volume of research on entrepreneurs and entrepreneurship, we lack knowledge about how entrepreneurial localisation in thick vs. thin RISs influence their innovativeness and growth ambitions (Rypestøl 2017). Svare and Gausdal (2015) have studied RISs as catalysts for entrepreneurial experimentation. Other scholars have addressed how RISs have implications for entrepreneurial access to social capital, institutional support, and other knowledge-based resources (Coenen 2007, Smith et al. 2014, Yoon et al. 2015). In a broader perspective, researchers have examined how the regional context influences entrepreneurial start-up patterns, -intentions, and -fear of failure (Turro, Alvarez, and Urbano 2016, Huggins and Thompson 2014, Kibler 2013, Walter and Dohse 2012, Bishop 2012, Liñán, Urbano, and Guerrero 2011, Zhou 2011). Yet despite this increasing body of literature, we have not found studies that explicitly examine entrepreneurs' growth ambitions and innovativeness in a

regional context. Granted, recent studies have shown how regional characteristics influence firms' ability to innovate, along with other facets of performance (e.g. Aarstad, Kvitastein, and Jakobsen 2016, Wixe 2015), but the studies focus on mature or established enterprises and provide no insight about entrepreneurial firms.

Taken together, our study fills an important gap in the research literature as it examines regions or RISs at a macro level as potential catalysts for entrepreneurial innovativeness and growth ambitions at a micro level. In a regional context, the agency role played by entrepreneurial firms at a micro level regarding innovativeness and growth ambitions can particularly be indicative of future path dependent features of RISs at a macro level, we argue. "Path dependence is a ubiquitous phenomenon, which pertains to firms and institutions at the micro level, and to regions… at the macro level" (Gjelsvik and Aarstad 2017, p. 408). Path dependence occurs when the current socioeconomic process depends on previous states (Castaldi and Dosi 2006). RISs can be strongly or weakly path dependent. A strongly path dependent RIS breeds preservation and continuation of the existing industry structure (cf. David 2001). In our context, it means that entrepreneurs as micro level agents "behave in accordance with the context of the existing industry structure into which they are embedded" (Gjelsvik and Aarstad 2017, p. 410). If entrepreneurs in an RIS are not innovative, they will tend to preserve the existing industry structure and breed equilibrium or continuation (cf. Kirzner 1973). In particular, the existing industry structure is preserved if entrepreneurs that are not innovative have weak growth ambitions. A weakly path dependent RIS, on the other hand, can breed path renewal or -creation (cf. Isaksen 2015). "Path renewal involves the growth of new activities and new industries… [while p]ath creation represents the growth of entirely new industries for a region…" (Isaksen and Jakobsen 2017, p. 356). Regional path renewal and -creation can evolve through micro-level processes of new firm formation (ibid.), and radical innovativeness among entrepreneurs in an RIS is likely to breed disruption or to decouple from the existing industry structure (Schumpeter 1934). In particular, the change or decoupling from the existing industry structure will take place if innovative entrepreneurs have strong growth ambitions (Rypestøl 2017). Acs et al. (2009, p. 16) assert that "[s]tart-ups with access to entrepreneurial talent and intra-temporal spillovers from the *stock* of knowledge are more likely to engage in radical innovation leading to new industries or replacing existing products." A major thesis of this paper is that "intra-temporal spillovers" abound in thick RISs, which increase entrepreneurial innovativeness and growth ambitions there.

Altogether, we argue that our study contributes to better understand the interplay between regions or RISs at the macro level and entrepreneurial firms' innovativeness and growth ambitions at the micro level as agents for path dependency in the local economy. The paper further contributes to the entrepreneurship research agenda as it introduces thickness of RISs to explain innovativeness and growth ambitions among this group of regional players. Innovation is the defined as "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations" (OECD/Eurostat 2005, p. 46, Bloch 2007, p. 28). Entrepreneurs are likely to be in different developmental stages, and some may not even have developed a marketable product or service. In order not to discriminate between entrepreneurs in different stages, we, therefore, ground our research question in their very perception of the innovativeness of the business idea. Likewise, we focus on the entrepreneurs' growth ambitions rather than de facto business growth.

The unit of analysis in this study is the entrepreneurial firm. Empirically, we analyse data from a survey of 870-917 entrepreneurial firms that are located in Agder of Southern Norway. Based on trade and labour markets, as defined by the EU's classification of local administrative units (LAU1), we identify two thick and six thin RISs in Agder. Agder is economically, culturally, judicially and linguistically homogenous, but diversified concerning the thickness of RISs. Agder, therefore, represents an ideal empirical context to study our research question, we argue. Econometrically, we analyse and compare if localization in either thick or thin RISs in Agder is associated with entrepreneurial innovativeness and growth ambitions. We apply robust ordinal logistical regression, which generates standard errors that correct for potential autocorrelation for firms operating in similar industries. In addition, it corrects for potential heteroscedasticity in the data. We also control for potential confounders that in their absence can induce spurious effects. Bootstrapping on the original sample can make inferences about the distribution of the underlying population of study. The technique can also correct for skewed sample distribution (see for instance Cameron and Trivedi 2010, Efron 1979). In some models, we, therefore, carry out 10,000 random bootstrapped replications with replacements on the original sample. We finally use coarsened exact matching (CEM) or "pruning" in some models to reduce the imbalance in the data concerning entrepreneurial firms located in thick vs. thin RISs. Using CEM to reduce imbalance decreases model dependence, generates less biased estimates, and increases internal validity (Iacus, King, and Porro 2011b, a, King and Zeng 2006). In the absence of a

randomized treatment and control group, which for obvious reasons is the case in the current study, King and Nielsen (2016) show that CEM has more robust properties to reduce data imbalance than propensity score matching (Rosenbaum and Rubin 1983).

The rest of the paper is structured as follow: In the next section, we elaborate two testable hypotheses suggesting that entrepreneurial firms located in thick RISs are more innovative and have stronger growth ambitions than entrepreneurial firms located in thin RISs. Then, we explain in detail the empirical context and the methodology that we use to test the hypotheses. In the following parts, we present the empirical results, discuss their theoretical and practical implications, address the study's limitations, and suggest avenues for future research.

Theory and Hypotheses

In their seminal note, Shane and Venkataraman (2000) define entrepreneurship as a dual process of discovery and exploitation of opportunities. Discovery is indicated by the formation of new firms, according to Davidsson and Honig (2003), and in our study, we likewise label entrepreneurship as the formation of new firms. Exploitation is the process by which entrepreneurs create value by acting upon opportunities, according to Kirzner (1973). He further asserts that entrepreneurs stabilize, rather than destabilize the economy, and they do not have to be innovative because profit can be extracted from market failure alone through imitating strategies (ibid.). Kirzner's arguing fits well into viewing entrepreneurs as agents for a strongly path dependent RIS by breeding preservation and continuation of the existing industry structure (cf. David 2001). Schumpeter (1934), on the other hand, asserts that entrepreneurs create value as they exploit opportunities through innovations that disrupt the status quo of market equilibrium. His arguing fits well into viewing entrepreneurs as agents for a weakly path dependent RIS by breeding disruption or decoupling from the existing industry structure (cf. David 2001).

Schumpeter and Kirzner are thus advocates of entrepreneurs as carriers for value creation in the economy through innovation or imitation, respectively. Innovation embodies a change from existing products or services. Minor changes are labelled incremental innovations while more fundamental changes are labelled radical innovations (Fagerberg, Mowery, and Nelson 2005). Imitation, on the other hand, embodies "more of the same" in that

firms aim to leverage products or services that previously have been developed and introduced to the market by others (Haunschild and Miner 1997). Innovations can accordingly be labelled along a continuum between radical in novelty vs. no novelty at all. No novelty at all embodies a pure imitation. In the following, we will argue how entrepreneurs located in thick RISs will tend to be more innovative along the continuum mentioned above than entrepreneurs located in thin RISs. Next, we will argue how entrepreneurs located in thick RISs will tend to have stronger growth ambitions than entrepreneurs located in thin RISs.

RISs and Entrepreneurial Innovativeness

Taking a systemic approach, Asheim and Gertler (2005) assert that regional knowledge bases are crucial for firms to develop innovative products or services in the marketplace. According to the authors, regional knowledge bases can be classified as analytical, synthetic or symbolic. The analytical type of knowledge is codified and R&D dominated, while the synthetic type of knowledge is experience based, tacit, and context-specific. The symbolic type of knowledge is creative, aesthetic, and artistic. Thick RISs have a prevalence of an analytical knowledge base, due to a relatively strong presence of R&D institutions along with an industry sector of a highly educated workforce (Isaksen and Trippl 2016). The innovation literature argues that an analytical knowledge base is important to increase innovation and novelty in the regional economy (Jensen et al. 2007). Empirical research has likewise shown that R&D investments are associated with innovation performance (e.g. Bhattacharya and Bloch 2004, Shefer and Frenkel 2005).

We find it likely to assume that innovation performance by firms with a predominantly analytical knowledge base in thick RISs will tend to spill over into the entrepreneurial activity in the region, independent of whether a startup firm explicitly invests in R&D or not. Our assumption in is line with Acs et al. (2009, p. 16) asserting that "[s]tart-ups with access to entrepreneurial talent and intra-temporal spillovers from the *stock* of knowledge are more likely to engage in radical innovation…" In other words, entrepreneurs in thick RISs will one way, or another be exposed to an analytical knowledge base, due to geographical proximity to other enterprises and industry actors in the region (Boschma 2005). An analytical knowledge base and a relatively strong presence of R&D institutions in thick RISs moreover lower the barriers for entrepreneurial firms to interact directly with firms (having analytical knowledge base) through labour mobility and the sourcing of scientific knowledge (Martin and

Moodysson 2013). Empirically, and in line with our arguing, Audretsch and Lehmann (2005) show that regional R&D spending and the presence of a local university, as indicators of an analytical knowledge base, increase the prevalence of knowledge-intensive startups. Entrepreneurs located in thin RISs, on the other hand, will be less exposed to an analytical knowledge base, but largely be exposed to a synthetic knowledge base (Isaksen and Trippl 2016). A synthetic knowledge base, which is experienced based and tacit (Asheim and Gertler 2005), can induce innovation performance, but it is likely to be more incremental, and less disruptive than innovation performance in a context of a predominantly analytical knowledge base (Isaksen and Karlsen 2012). Entrepreneurs located in thin RISs will accordingly have less exposure to stimuli that induce the leveraging of innovative products or services in the marketplace than entrepreneurs located in thick RISs. At the same time, they have less explicit regional access to R&D knowledge in the entrepreneurial process of developing their firm, we argue.

A thick RIS will tend to have an ample diversified or specialized industry sector (Isaksen and Trippl 2016). Recent studies have shown that regions with a diversified industry structure can increase the innovation performance by enterprises that are located there (Castaldi, Frenken, and Los 2015, Tavassoli and Carbonara 2014, Aarstad, Kvitastein, and Jakobsen 2016). A reason for this is that diversity in the regional economy breeds a potential to recombine resources in novel ways. It furthermore provides access to non-redundant information or other resources that can propel the advancement of the novel and innovative products or services (Burt 2004).

Following this reasoning, one may assume that a thick RIS predominately having a specialized industry structure will hamper innovation performance in the regional economy. However, studies are indicating that a specialized industry structure will, in fact, increase the innovation performance for firms with an analytical knowledge base (Duranton and Puga 2001, Shefer and Frenkel 1998). A reason for this is perhaps that a specialized regional economy provides a critical mass for an analytical knowledge base to reach its innovative potential by generating a common understanding of R&D activities in the local economy (Bania, Calkins, and Dalenberg 1992, Gassmann and von Zedtwitz 1999).

Taken together, we conclude that a thick RIS will tend to foster a local competence, and even an attitude, that will tend to spill over into the pool of local entrepreneurs concerning the developing of innovative products or services. A thick RIS, having a strong industry base,

will accordingly induce entrepreneurs to “exploit spillovers from the source of knowledge production” (Acs et al. 2009, p. 17). A thin RIS, on the other hand, will tend to have a limited industry sector altogether or rely upon one or a few local enterprises (Karlsen 2013), which neither fosters recombination of local resources from a diversified industry sector, nor a critical mass of specialized analytical knowledge. This will constrain entrepreneurs located in thin RISs to have a proclivity to leverage innovative products or services in the marketplace, we argue.

A thick RIS will also tend to be rich in symbolic knowledge (Asheim and Gertler 2005), due to a strong prevalence of cultural, artistic and aesthetic activities in educational institutions and the public sector. In a similar vein, a thick RIS will tend to have a strong prevalence of local enterprises operating in creative industries such as mass media, design, and architecture, to mention a few sectors. Accompanied by an analytical knowledge base, we find it likely to assume that a relatively strong prevalence of a symbolic knowledge base in thick RISs will tend to spill over into the local pool of entrepreneurs fostering creativity and innovative ideas among them. Low degree of a symbolic knowledge base in thin RISs, on the other hand, largely lacking the institutions and industries mentioned above, will constrain innovative strategies among entrepreneurs operating in the local economy. Altogether, we conclude and hypothesize that entrepreneurs located in thick RISs will be more innovative than entrepreneurs located in thin RISs.

Hypothesis 1 (H1): Entrepreneurs located in thick RISs will be more innovative than entrepreneurs located in thin RISs.

RISs and Entrepreneurial Growth Ambitions

A thick RIS will tend to have an ampler industry sector and to be more urbanized and densely populated than a thin RIS, according to Isaksen and Trippl (2016). This implies that industry actors are more geographically proximate to each other in a thick than in a thin RIS. Referring to Krugman (1991) and Boschma (2005), Aarstad, Kvitastein, and Jakobsen (2016, p. 847) assert that “geographical proximity in densely populated regions means that

enterprises can serve a market that is locally accessible. This reduces transportation costs and increases market size, which facilitates a high volume of sales revenues of products and services assembled at a relatively low cost, because of the economies of scale from serving numerous buyers. A large market and geographical proximity to other markets may also facilitate stability in demand…" This arguing implies that enterprise revenues and productivity gains are relatively high in urbanized and densely populated regions. Empirical studies point in the same direction (e.g. Wixe 2015, Aarstad, Kvitastein, and Jakobsen 2016), and we consequently assume that entrepreneurs being localized in thick RISs, predominately having an ample industry sector and a high population density, will induce aspirations of strong growth ambitions among them. They will tend to perceive a relatively large local market and stability in demand. Productivity and revenue gains accumulated by established enterprises may further propel aspirations of a strong local demand for their products and services. Proximity to other markets may additionally induce an entrepreneurial aspiration of strong growth ambitions, we argue.

Thick RISs can furthermore have an overall specialized industry sector (Isaksen and Trippl 2016), and studies have shown that industry specialization is another regional driver of enterprise revenues and productivity gains (Aarstad, Kvitastein, and Jakobsen 2016, Wixe 2015). Possible reasons for this is the ability of economies of scale in specialized industries (Glaeser et al. 1992, Marshall 1890), along with cognitive, organizational, institutional and social proximity among stakeholders in the region (Boschma 2005). Cognitive, organizational, institutional and social proximity induce the capability to coordinate efforts across enterprises and to smooth communication and coordination of joint efforts in a regional context of mutual understanding. Because of potentially high productivity gains in thick RISs with a specialized industry sector, this will further induce strong growth ambitions among entrepreneurs that are located in such a context, we argue. As stated above, productivity and revenue gains accumulated by established enterprises may further propel aspirations of a strong local demand for their products and services. Granted, thick RISs can also have a predominantly diversified industry sector (Isaksen and Trippl 2016), and which may be detrimental to the productivity gains mentioned above. However, in many urbanized regions a diversified industry sector tend to induce a strong prevalence of enterprises operating in related industries, and which does not preclude productivity gains as compared to a specialized structure (Aarstad, Kvitastein, and Jakobsen 2016).

A thin RIS, on the other hand, will tend to have a relatively meagre industry sector and to be more sparsely populated than a thick RIS, according to Isaksen and Trippl (2016). This implies that the productivity gains achieved in thick RISs are less probable for enterprises located in thin RISs. For entrepreneurs located in thin RISs, this will induce aspirations of relatively low growth ambitions among them, we argue. They will tend to perceive a relatively small local market and possibly less stability in demand. Relatively low productivity and revenue gains accumulated by established enterprises may further propel aspirations of a limited local demand for their products and services. Altogether, we conclude and hypothesize that entrepreneurs located in thick RISs will have stronger growth ambitions than entrepreneurs located in thin RISs.

Hypothesis 2 (H2): Entrepreneurs located in thick RISs will have stronger growth ambitions than entrepreneurs located in thin RISs.

Methodology

Research Context and Identification of Thick vs. Thin RISs

The extended regional context that we study in this paper is Agder in the southernmost part of Norway. We have noted that Agder is economically, culturally, judicially and linguistically homogenous, but diversified concerning the thickness of RISs. It, therefore, represents an ideal empirical context to test our hypotheses, we argue. Agder covers an area of about 16,400 m^2 and has a southern coastline of 1,466 km to the North Sea. It has a strong economic history rooted in forestry and shipping. In the 17th century, Agder had a well-developed sales network of lumber, including merchants from England, the Netherlands, and Denmark. Agder is divided into two counties, East Agder (Aust-Agder) and West Agder (Vest-Agder), and consists of 30 municipalities. The total population in Agder is about 284,000. Following the EU's classification of local administrative units (LAU1), Statistics Norway divides Agder into eight economic regions. The criteria for divisions are based on trade and labor markets.

Among the eight economic regions in Agder, we classify (the extended regions of) Kristiansand and Arendal as thick RISs. Kristiansand has about 121,000 inhabitants and is the most populous region of Agder. It consists of four municipalities (Kristiansand, Vennesla, Songdalen, and Søgne). Kristiansand is county capital of West Agder and accordingly, hosts numerous governmental organization. The region moreover has an international airport and is a national hub concerning ferry transport between Norway and Denmark, and the European continent. Kristiansand hosts the major part of the University of Agder with about 8,500 students, in addition to a few other specialized colleges for higher education. Kristiansand has a strong industry sector, particularly in the mechatronic sector and is also a strong national tourism destination hosting one of the largest adventure parks in Norway.

Arendal, the other region which we classify as a thick RIS, has about 83,000 inhabitants and is the second most populous region in Agder. It consists of six municipalities (Arendal, Grimstad, Vegårdshei, Tvedestrand, Froland, and Åmli). Arendal is the capital of East Agder and accordingly, hosts numerous governmental organizations. It furthermore hosts a large part of the University of Agder, with about 3,500 students. Arendal also has a strong industry sector, particularly mechanical industry and electronic industry.

We classify the six remaining economic regions of Agder as thin RISs. They are (the extended regions of) Risør, Lillesand, Setesdal, Mandal, Lyndal/Farsund, and Flekkefjord. The regions have low population, host a limited amount of governmental organizations, do not represent major hubs concerning transport, have practically no higher education institutions, and have a limited industry sector.

Figure 1 maps the division of economic regions in Southern- and Mid-Norway, including the eight economic regions in Agder (West Ager/Vest-Agder and East Agder/Aust-Agder). Figure 2, in particular, illuminates how Kristiansand and Arendal are relatively urbanized, while the remaining area of Agder practically has no urbanization at all (the absence of urbanization is also the case concerning the area of Agder not included in the map). The maps in Figure 1 and 2 are derived from Statistics Norway.

Figure 1. Economic regions in Southern- and Mid-Norway, including Agder (West Agder/Vest-Agder and East Agder/Aust-Agder).

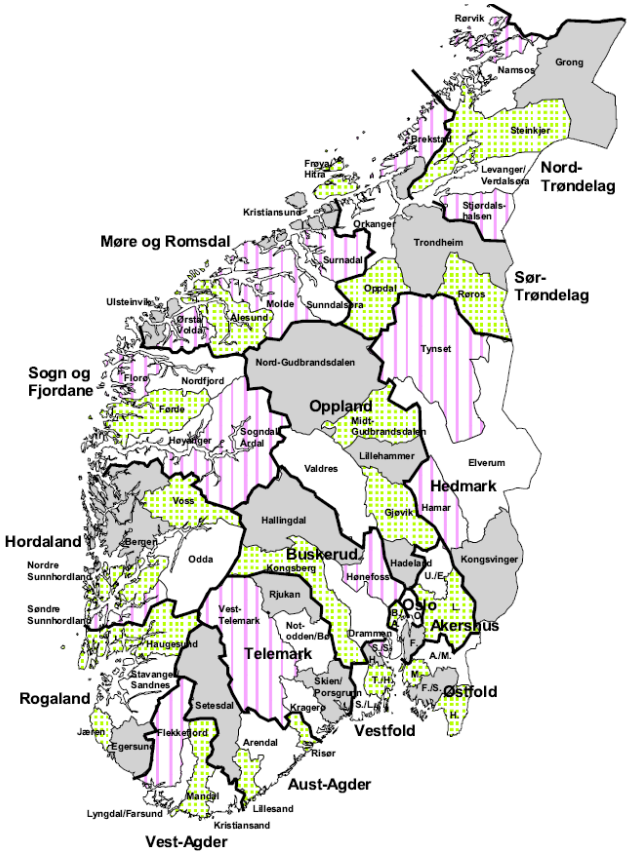
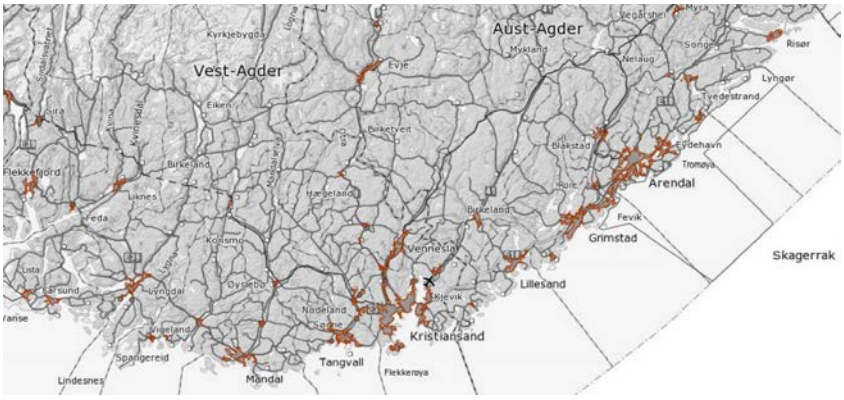


Figure 2. Urbanization in Agder (West Agder/Vest-Agder and East Agder/Aust-Agder).



In Table 1, we summarize central characteristics that illuminate our classification of RISs in Agder as either thick or thin. The data are based on the European System of National and Regional Accounts (ESA) manual and other publically available data for Agder (except for the rows "Industry relatedness (diversification)" and "Industry specialization," which we discuss shortly). We observe that the RISs' industry base are in line with what we have reported. The table furthermore reveals that Kristiansand and Arendal have a relatively high amount of large size corporations along with a relatively high number of financial corporations. Kristiansand and Arendal also host three and one formalized industry clusters, respectively (while the other RISs have none), indicating a tendency of regional industry specialization.

Table 1. Characteristics of regions classified as thick vs. thin RISs.

	Kristiansand	**Arendal**	**Risør**	**Lillesand**	**Setesdal**	**Mandal**	**Lyngdal/ Farsund**	**Flekkefjord**
Population size (in thousand)	121	83	9	16	8	26	20	17
County capital	Yes	Yes	No	No	No	No	No	No
Small non-financial corporations 0-4 employees	5045	2932	363	571	395	1158	758	673
Large non-financial corporations >250 employees	9	4	0	0	0	1	2	1
Total number of non-financial corporations	6840	4003	489	735	537	1497	1058	905
Number of financial corporations	91	51	4	6	7	16	16	9
Number of general governmental organizations	534	473	80	129	157	206	127	166
Number of formalized industry clusters	3	1	0	0	0	0	0	0
Industry relatedness (diversification)	.143	.137	.110	.073	.102	.114	.069	.043
Industry specialization	1.39	1.32	1.19	1.18	1.38	1.18	1.19	1.05
Classification of RIS	**Thick**	**Thick**	Thin	Thin	Thin	Thin	Thin	Thin

Data in the rows "Industry relatedness (diversification)" and "Industry specialization" are based on Aarstad et al.'s (2016) regional entropy measure of related variety and the inverse entropy measure of unrelated variety (we divide the entropy measures by the natural logarithm of the number of enterprises analysed in each region to take account of the size of

the industry sector, cf. Minosse et al. 2006). The data give information about whether a region has a complementary and overlapping industry sector, and/or a specialized industry sector (or more correctly, the absence of a fragmented and unrelated industry sector). We observe that Kristiansand and Arendal have the highest scores of industry relatedness. They also have the highest (Kristiansand) and third highest (Arendal) scores of industry specialization. (Setesdal has higher industry specialization than Arendal, but it is a small and remote region strong in winter sports tourism, hydroelectricity production, and local craftsmanship. It is possible that the low number of enterprises analysed has artificially inflated the entropy measure of industry specialization in Setesdal.) Taken together, we conclude that it is defendable to classify Kristiansand and Agder as thick RISs and the remaining six regions as thin RISs.

Data Collection Procedure

As noted, we have defined entrepreneurship as a dual process of discovery and exploitation of opportunities (Shane and Venkataraman 2000), in which discovery is indicated by the formation of new firms (Davidsson and Honig 2003). To identify the formation of new firms, we first carried out an electronic search at a publically available search engine, called "Purehelp." We restricted our search to only include firms that were localized in Agder and that were formally established between January 1, 2009, and June 1, 2014 (data collection took place after June 1, 2014). In line with our sampling approach, OECD (2014, p. 2) defines "[s]tartups and young businesses… …as firms of 5 years old or less". We identified 6,993 firms with an identifiable email address. To these firms we sent an electronic survey (which we describe shortly) followed up by two reminders to none-responding firms. In total, we received 872 valid responses (some regressions we run later have 917 observations in models that exclude control variables). 609 of the valid responses were located in thick RISs, and 263 were located in thin RISs. It implies a response rate of 12.5% and 12.4% in thick and thin RISs, respectively. Skewness in response rate between thick and thin RISs is accordingly negligible, we argue. Firms operating in the following industry sections were excluded from the study: public administration and defence, compulsory social security, activities of households as employers, and activities of extraterritorial organisations and bodies.

Dependent Variables

Innovativeness is one of the dependent variables for this study. To have a relatively coherent understanding of what an innovation is, we framed the respondents with a translated version of the OECD Oslo manual's definition of the concept as "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations" (Bloch, 2007, p. 28; OECD/Eurostat, 2005, p. 46). This phrase is the very same definition of innovation that we have applied in our study, and it is also used in the community innovation survey (CIS) carried out biannually in the Eurostat area.

After reading the text in Norwegian, the respondents were requested to indicate whether they perceived their firm to be innovative or not. Those respondents indicating that their firm was innovative were next requested to indicate on a three-point scale to what *extent* they perceived the firm to be innovative. To measure innovativeness, we accordingly have an ordinal four-point scale varying between no innovative at all to radically innovative. We also replicate our analyses with a binary (instead of an ordinal) measure to distinguish between those who perceive that their firm is innovative vs. those who do not. All statistical conclusions, we will later show, point in the same direction. As an alternative to using survey responses to measure innovativeness, we could potentially have used patents counts, but entrepreneurs in different stages may have very different proclivities to patent their business idea. Our definition of innovation in the current study, in addition, goes far beyond viewing merely tangible products or services as innovative (cf. our definition of innovation). Patenting is moreover a measure of *inventions* rather than innovations (Sichelman 2010). Patenting can finally take place for strategic reasons, and not only as a mean to protect innovations, according to scholars (Arundel 2001, Hall and Ziedonis 2001, Watanabe, Tsuji, and Griffy-Brown 2001).

Growth ambition is the other dependent variable for this study. To measure the concept, we asked the respondents to indicate on a four-point scale their growth ambitions for the firm. Growth ambitions can be high or moderate. They can furthermore be neutral (the firm is satisfied with status quo) or even negative (the firm aims to downsize its operations). Our four-point ordinal scale captured these different perceptions of growth ambitions.

Control Variables

We have explained that entrepreneurial firms formally established in Agder between January 1, 2009, and June 1, 2014, were targets for the study. Yet despite that we have the formal year of establishment, we nevertheless asked the respondents to indicate which year it was established. A major reason for this approach is that the time period of formalized establishment and the entrepreneur's more genuine perception of the time period when the firm was established may deviate. In this study, we accordingly used the entrepreneurs' self-reported year of establishment as a nominal dummy variable to control for firm age and potential cohort effects (Aldrich 1999). 73 respondents reported that their firm was established before January 2009 and they were grouped into the same age cohort. For the rest of the sample, we grouped firms together into the respective year cohort of the reported establishment.

We also control for the firms' reported turnover or revenues. A relatively large share of the respondents reported 0 or marginal revenues and the variable was accordingly skewed. We, therefore, corrected for this by first adding the constant of 1 (since some firms had reported 0 turnover) and next applied the natural logarithm to the variable. We assume that entrepreneurs in need for R&D competence may be associated with innovativeness and growth ambitions. Entrepreneurs located in thick RISs may potentially also report higher proclivity to apply R&D competence in their firm, due to relatively high proximity to academic institutions and a predominately analytical knowledge base (Boschma 2005, Asheim and Coenen 2005). We, therefore, asked the respondents to report whether they were in need for collaboration with an R&D institution throughout the entrepreneurial process and included a binary variable to control for this factor. Responding yes to this question was coded 1, and no was coded 0. Also, we control for whether the respondents were so-called novice entrepreneurs or not. Research has shown that novice entrepreneurs vs. entrepreneurs with previous startup experience in many aspects have very different approaches to the venture process (e.g. Aarstad, Pettersen, and Henriksen 2016, Robson et al. 2013), and which is a major reason for controlling out this potential cofounder. Responses indicating that the entrepreneur had established its very first venture was coded 1, and responses indicating that the entrepreneur had previous startup experience was coded 0. We finally control for entrepreneur firms operating in different industries and explain this issue in the Results section.

Results

We analyze the data for this study in Stata 14.2 (StataCorp. 2015). In the econometric models, we apply robust ordinal logistical regression, which generates standard errors that correct potential autocorrelation for firms operating in similar industries (in some models, we apply robust binary logistic regression). The regression technique also corrects for potential heteroscedasticity in the data. To classify the industry in which the entrepreneurs were operating, respondents were requested to describe the core idea of their business shortly. From this description, we identified each firm in accordance with the EU's NACE classification of industry sections. 116 (of a total of 917) respondent who did not respond to our request were grouped into a separate section.

Testing H1

We hypothesized that entrepreneurs located in thick RISs would be more innovative than entrepreneurs located in thin RISs (H1). In Table 2, we empirically test H1 and observe in Model 1 that it gains significant empirical support. The variance inflation factor (VIF) is 1.01 concerning H1. Multicollinearity is accordingly not a problem (cf. O'Brien 2007). Unsurprisingly, we observe that respondents reporting, "Need for R&D collaboration" are relatively innovative. Model 1 finally shows that also novice entrepreneurs are relatively innovative. This may imply that serial- or portfolio entrepreneurs, having experience in leveraging more than one enterprise, appear to be less innovative than novice entrepreneurs. The Wald χ^2 is significant in Model 1 (and which is also the case in all reported models in Table 2) indicating robust model fit.

In Model 2, we omit the control variable "Need for R&D collaboration," and the hypothesized effect is (unsurprisingly) somewhat stronger. In other words, our empirical findings show that entrepreneurs located in thick RISs are more innovative than entrepreneurs located in thin RISs, but the effect is partly mediated by their need for R&D collaboration (as we observe by the increased hypothesized effect in Model 2 when omitting the variable "Need for R&D collaboration").

Table 2. Robust ordinal logistic regression with innovativeness as dependent variable.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Thick RISs (H1)	.368**	.413**	.436***	.436***	.513***	.520***
	(.133)	(.128)	(.126)	(.127)	(.111)	(.111)
Turnover (log)	-.042	-.013	.086	.086	.033	
	(.170)	(.152)	(.139)	(.141)	(.110)	
Need for R&D collaboration	1.51***					
	(.155)					
Novice entrepreneur	.476**	.540**				
	(.182)	(.205)				
Intercept 1	3.04***	1.16***	1.01**	1.01**	1.21***	1.41***
	(.407)	(.333)	(.311)	(.321)	(.337)	(.159)
Intercept 2	3.72***	1.78***	1.63***	1.64***	1.82***	2.02***
	(.407)	(.326)	(.308)	(.316)	(.329)	(.175)
Intercept 3	5.27***	3.27***	3.12***	3.12***	3.27***	3.46***
	(.409)	(.336)	(.330)	(.333)	(.351)	(.203)
Dummy for year established	Yes	Yes	Yes	Yes	Yes	No
Bootstrapping	No	No	No	Yes	No	No
Matching/"pruning" of data	No	No	No	No	Yes	Yes
Wald χ^2	582.8***	36.2***	23.8**	22.1**	29.0***	21.9***
Log pseudo likelihood	-706.0	-737.3	-794.6	-794.6	-727.7	-730.5
N total	872	872	917	917	870	870
N in thick RISs	609	609	643	643	603	603
N in thin RISs	263	263	274	274	267	267
Number of industries	18	18	19	19	19	19

Two-tailed tests of significance. Robust standard errors in parentheses adjusted for industry effects (bootstrapped robust standard errors in Model 4). † p < .10, * p < .05, ** p < .01, *** p < .001

In Model 3, we also omit the control variable indicating whether the respondent is novice entrepreneur or not. Our motive for omitting this variable is that a relatively large number of entrepreneurs did not respond to this question. In its absence, we accordingly achieve a higher number of responses in our analyses. We observe that H1 still gains empirical support in Model 3, and the hypothesized effect is even stronger and more robust now than what we saw in the previously reported models.

We have noted that bootstrapping on the original sample can make inferences about the distribution of the underlying population of study. The technique can also correct for skewed sample distribution (see for instance Cameron and Trivedi 2010, Efron 1979). In Model 4, we, therefore, replicate Model 3 with bootstrapping carrying out 10,000 random replications with replacements on the original sample. We observe that the empirical findings reported in Model 4 (with bootstrapping) compared with those reported in Model 3 (without bootstrapping) are practically identical (except for slightly higher reported standard errors in Model 4).

In Model 5, we use coarsened exact matching (CEM) or "pruning" to reduce the imbalance in the data concerning entrepreneurial firms located in thick vs. thin RISs. We have noted that using CEM to reduce imbalance decreases model dependence, generates less biased estimates and increases internal validity (Iacus, King, and Porro 2011b, a, King and Zeng 2006). In the absence of a randomized treatment and control group, which for obvious reasons is the case in the current study, King and Nielsen (2016) show that CEM has more robust properties to reduce data imbalance than propensity score matching (Rosenbaum and Rubin 1983). Following the matching or "pruning" procedure in Stata as recommended by Blackwell et al. (2009), we first applied entrepreneurs located in thick and thin RISs as "treatment" and "control" group, respectively. Next, we used CEM to match or "prune" the sample (between entrepreneurial firms in the "treatment" and the "control" group, respectively) on the variables "Turnover" (revenues), year of establishment, "Need for R&D collaboration," and "Novice entrepreneur." King and colleagues recommend dividing the data for each variable into relatively crude strata in order to preserve a relatively high number of observations in subsequent analyses (Iacus, King, and Porro 2011b, a, King and Zeng 2006). (Thereby the name *coarsened* exact matching.) For the variable "Turnover", we therefore divided the entrepreneurs into three different strata by letting each strata contain as similar number of observations as possible. We followed a similar procedure for the year of establishment variable. For the variables "Need for R&D collaboration" and "Novice entrepreneur" we only have binary values. For each of these variables, we therefore divided observations into two strata. Following the default option for CEM in Stata, missing observations for some of the variables were treated as separate strata (see Blackwell et al. 2009, p. 538 for further details).

The CEM procedure in Stata identified a total of 32 matched or "pruned" strata or bins (of a total of 47) that contain firm observations from both the "treatment" and the "control" group (observations in 15 unmatched strata or bins were accordingly deleted from further analyses). Model 5 reports that 870 observations (of a total of 917) remain in the sample after matching or "pruning" the data; 603 in thick RISs (the "treatment" group) and 276 in thin RISs (the "control" group). On this matched or "pruned" sample we carried out robust ordinal logistic regression, as in the previous models, except that we followed Blackwell et al.'s (2009, p. 537) recommendation to weight observations according to the relative number of firms in thick ("treatment" group) vs. thin ("control" group) RISs for each stratum or bin. E.g., if the number of firms in a strata or bin is 9 for the "treatment" group and 4 for the "control" group, each firm observation for the "control" group is given a relative weight of

9/4=2.25 in the analysis (for firms in the "control" group belonging the respective strata or bin). If the number of firms in another stratum or bin is 5 for the "treatment" group and 8 for the "control" group, each observation for the "control" group is given a relative weight of 5/8=.63 in the analysis (for firms in the "control" group belonging to the respective strata or bin). Model 5 in Table 2 shows that H1 gains strong and robust empirical support after matching or "pruning" the sample data. In fact, the estimate is stronger, and the standard error is lower than in the previously reported models. (It is redundant to control for "Need for R&D collaboration" and "Novice entrepreneur" since the sample data was perfectly matched or "pruned" on these variables.)

While most regression normally generates one intercept or constant term, ordinal logistic regression generates *u*-1, where *u* is the number of ordinal values for the dependent variable. Table 2 accordingly includes three intercepts. Intercepts, in tandem with regression estimates, can be used to predict the occurrence of different groups of observations (Hamilton 2013). In this study, we are particularly interested in predicting the occurrence of firms' innovativeness in thick vs. thin RISs. To address this issue, we first re-estimate Model 5, but omit turnover and dummy for year established as control variables, and report the results in Model 6. (Omitting the control variables facilitates the estimation of homogenous occurrences of different ordinal values of innovativeness in thick vs. thin RISs.) We observe that the regression estimates measuring H1 are similar in Model 5 and 6. Next, we apply from Model 6 the estimate measuring H1 and the intercepts to predict the occurrence of innovativeness in thick vs. thin RISs, and report the results in the left part of Table 3 under the label *Logit*. (Hamilton 2013 shows how regression estimates and intercepts can be used manually to predict the occurrence of groups of observations, but in this study, we apply the postestimation syntax in Stata.) In thick RISs, we observe a relatively low percentage of non-innovative firms (score 1) and a relatively high and consistent percentage of innovative firms at varying degrees (scores 2-4). The data are consistent with statistics reported in Table 2 and further indicate empirical support for H1. In the right part of Table 3 under the label *Tabulate*, we present cross-tabulation estimates, and the results are very consistent with those reported in the left part of the table.

Table 3. Prediction of innovativeness in thick vs. thin RISs.

	Logit		*Tabulate*	
	Thick RISs	Thin RISs	Thick RISs	Thin RISs
1	70.84%	80.34%	69.67%	78.10%
2	10.88%	7.92%	11.35%	8.76%
3	13.28%	8.70%	13.84%	9.85%
4	5.00%	3.04%	5.13%	3.28%
Sum	100%	100%	100%	100%

1 implies not innovative at all, while 4 implies radically innovative. Logit predictions are based on regression estimate and intercepts reported in Model 6, Table 2. Tabulate predictions are based on cross-tabulation estimates. N=917 for the tabulate estimates.

In Table 4, we replicate the analyses from Models 1-5 in Table 2, but we instead use a binary measure of the dependent variable and run robust logistic (logit) regressions to calculate odds ratios for innovativeness in thick vs. thin RISs. The binary measure accordingly makes a distinction between those respondents who perceive that their firm is innovative vs. those who do not (cf. our previous discussion).

Table 4. Robust logistic (logit) regression reporting odds ratios. Innovativeness is dependent variable.

	Model 1	Model 2	Model 3	Model 4	Model 5
Thick RISs (H1)	1.50**	1.53***	1.55***	1.55***	1.69***
	(.190)	(.183)	(.188)	(.194)	(.167)
Turnover (log)	1.03	1.03	1.14	1.14	1.06
	(.170)	(.152)	(.158)	(.160)	(.119)
Need for R&D collaboration	5.50***				
	(1.04)				
Novice entrepreneur	1.65*	1.74*			
	(.347)	(.381)			
Intercept	.036***	.310***	.352***	.352**	.301***
	(.016)	(.104)	(.110)	(.114)	(.102)
Dummy for year established	Yes	Yes	Yes	Yes	Yes
Bootstrapping	No	No	No	Yes	No
Matching/“pruning” of data	No	No	No	No	Yes
Wald χ^2	476.8***	30.7***	27.7***	25.2**	44.0***
Log pseudo likelihood	-461.0	-495.6	-533.6	-533.6	-493.0
N total	872	872	917	917	870
N in thick RISs	609	609	643	643	603
N in thin RISs	263	263	274	274	267
Number of industries	18	18	19	19	19

Two-tailed tests of significance. Robust standard errors in parentheses adjusted for industry effects (bootstrapped robust standard errors in Model 4). † p < .10, * p < .05, ** p < .01, *** p < .001

The overall statistical conclusion from Table 4 is the same as for Table 2, and we observe that the odds ratios for innovativeness in thick vs. thin RISs vary between 1.50 and 1.69. This implies that the probability of entrepreneurial innovativeness is between 50 and 69% higher in thick than in thin RISs.

Testing H2

We hypothesized that entrepreneurs located in thick RISs would have stronger growth ambitions than entrepreneurs located in thin RISs (H2). In Table 5, we empirically test H2 following the same approach as we did when testing H1 in Table 3 (Models 1-5). We observe, however, that H2 is statistically rejected in all of the reported models in Table 5. The table nevertheless shows that respondents reporting "Need for R&D collaboration" have relatively strong growth ambitions (Model 1). The finding indicates that entrepreneurs with an analytical knowledge base tend to have relatively strong growth ambitions.

Table 5. Robust ordinal logistic regression with growth ambition as dependent variable.

	Model 1	Model 2	Model 3	Model 4	Model 5
Thick RISs (H2)	.071	.129	.137	.137	.086
	(.125)	(.120)	(.123)	(.128)	(.122)
Turnover (log)	.141	.131	.324**	.324**	.289*
	(.148)	(.144)	(.117)	(.122)	(.120)
Need for R&D collaboration	1.11***				
	(.157)				
Novice entrepreneur	.387**	.428***			
	(.126)	(.128)			
Intercept 1	-2.39***	-3.65***	-3.55***	-3.55***	-3.44***
	(.540)	(.502)	(.463)	(.472)	(.525)
Intercept 2	1.25**	-.051	.052	.052	.174
	(.458)	(.403)	(.376)	(.379)	(.397)
Intercept 3	3.42***	2.04***	2.08***	2.08***	2.19***
	(.466)	(.406)	.387)	(.389)	(.407)
Dummy for year established	Yes	Yes	Yes	Yes	Yes
Bootstrapping	No	No	No	Yes	No
Matching/"pruning" of data	No	No	No	No	Yes
Wald χ^2	173.7***	83.8***	56.8***	48.7***	27.7***
Log pseudo likelihood	-922.7	-940.7	-1000.8	-1000.8	-950.1
N total	872	872	917	917	870
N in thick RISs	609	609	643	643	603
N in thin RISs	263	263	274	274	267
Number of industries	18	18	19	19	19

Two-tailed tests of significance. Robust standard errors in parentheses adjusted for industry effects (bootstrapped robust standard errors in Model 4). † p < .10,* p < .05, ** p < .01, *** p < .001

We furthermore observe that also novice entrepreneurs have relatively strong growth ambitions (Model 1 and 2). This may imply that serial- or portfolio entrepreneurs, having experience in leveraging more than one enterprise, appear to lower their growth ambitions as compared to novice entrepreneurs. We finally observe in some models that entrepreneurs with high turnover report relatively high growth ambitions (Models 3-5), but the effect is not significant when controlling for "Need for R&D collaboration" and "Novice entrepreneur" (Model 1 and 2).

In Table 6, we predict the occurrence of growth ambitions using cross-tabulation estimates, and we observe less marked differences between thick vs. thin RISs (as compared to predictions of innovativeness reported in Table 3). The data are consistent with statistics reported in Table 5 and further indicate lack of empirical support for H2. (We use cross-tabulation estimates only and not prediction on regression estimate and intercepts due to lack of empirical support for H2.)

Table 6. Prediction of growth ambitions in thick vs. thin RISs based on cross-tabulation estimates.

	Thick RISs	Thin RISs
1	2.02%	1.82%
2	38.26%	43.07%
3	43.70%	39.42%
4	16.02%	15.69%
Sum	100%	100%

1 implies negative growth ambitions, while 4 implies high growth ambitions. N=917.

Conclusion

The aim of this study was to examine if entrepreneurs' localisation in thick vs. thin RISs influences their innovativeness and growth ambitions. Thick RISs are predominately urbanized spaces that include organizations of higher-level education, R&D intensive milieus and an ample industry sector (Asheim and Gertler 2005, Isaksen and Trippl 2016, Tödtling and Trippl 2013), while thin RISs to a lesser degree encompass these features (Karlsen 2013). Empirically, we analysed data from a survey of 870-917 entrepreneurial firms that were located in Agder of Southern Norway. Identifying two thick and six thin RISs in Agder, our econometric analyses showed that entrepreneurs located in thick RISs were more innovative than their peers in thin RISs were. Concerning growth ambitions, there were no significant differences between entrepreneurs in thick vs. thin RISs, our data showed.

Theoretical and Practical Implications

Finding that entrepreneurs located in thick RISs were more innovative than entrepreneurs located in thin RISs is in accordance with our arguing that a predominately analytical or creative knowledge base and the presence of an ample specialized or diversified industry sectors foster entrepreneurial innovativeness. The innovation effect is robust even when controlling for entrepreneurs' reported need for R&D collaboration. This can indicate that the proximity of a predominately analytical knowledge base in thick RISs will tend to spill over into the regional entrepreneurial milieu (Acs et al. 2009, Audretsch and Lehmann 2005), independent of whether a start-up firm has an explicit R&D approach or not.

We argued that entrepreneurs localized in thick RISs, predominately having an ample industry sector and a high population density, will aspire strong growth ambitions among them. They will tend to perceive a relatively large local market and stability in demand. Productivity and revenue gains accumulated by established enterprises may further propel aspirations of a strong local demand for their products and services. However, our data revealed that entrepreneurs in thick RISs did not report significantly higher growth ambitions than entrepreneurs in thin RISs did. This indicates that entrepreneurial growth ambitions are insensitive to the characteristics of RISs and are consequently more strongly related to firm- and personal characteristics. In an unreported model, we found that innovative entrepreneurs have relatively strong growth ambitions, and thick RISs may, therefore, have an indirect

effect on growth ambitions through innovation. We have nevertheless no clear explanation of why thick RISs do not explicitly induce entrepreneurial growth ambitions. A potential explanation, however, is that the particular context studied in this paper does not sufficiently discriminate between thickness of RISs to generate significant differences. A second potential explanation is that other regional characteristics than thickness of RISs induce entrepreneurial growth ambitions. A final alternative or complementary explanation is that growth ambitions are simply triggered by other means than the regional context in which entrepreneurial firms are located. These issues require further investigations in future research, we argue.

In the Introduction, we emphasized that the agency role played by entrepreneurial firms at a micro level could indicate path dependent features of RISs at a macro level. RISs can be strongly or weakly path dependent. A strongly path dependent RIS breeds preservation and continuation of the existing industry structure (cf. David 2001), which means that entrepreneurs as micro level agents "behave in accordance with the context of the existing industry structure into which they are embedded" (Gjelsvik and Aarstad 2017, p. 410). If entrepreneurs in an RIS are not innovative, they will tend to preserve the existing industry structure and breed equilibrium or continuation (cf. Kirzner 1973), we argued. On the other hand, if entrepreneurs in an RIS are innovative, they will tend to breed path renewal and -creation inducing disruption or decoupling from the existing industry structure (Isaksen and Jakobsen 2017, Schumpeter 1934). Finding that entrepreneurial firms are less innovative in thin than in thick RISs, may, therefore, imply that they induce strong industry path dependency in thin RISs, preserving the existing industry structure, and weak path dependency in thick RISs, inducing new industry paths in the regional economy. Policymakers and other stakeholders should be aware of these potential mechanisms inducing diverging industry patterns in thick vs. thin RISs, respectively. To enable thin RISs to create industry path renewal and -creation, one should particularly be aware of the aforementioned micro level issues at play and aim to stimulate entrepreneurial innovativeness for instance through incubation programs, entrepreneurial programs leveraged by technology transfer offices or through other policy-induced means. Alternatively or complementary, policymakers and other stakeholders in thin RISs should aim to stimulate innovation in established enterprises in the region.

From an entrepreneurial perspective, we also argue that our study has relevant implications. The very knowledge that entrepreneurs in thick RISs will tend to be more innovative than their peers in thin RISs is valuable knowledge concerning those candidates

considering leveraging a venture, and eventually *where* to establish it. Anything else being equal, our study shows that locating a firm in a thick RIS will stimulate an innovative perspective that appears to be less prevalent in a thin RIS. For many entrepreneurs, this may not be a relevant issue to consider at all, but for those entrepreneurs in pursuing an innovative idea, locating a firm in a thick RIS will imply that they are more likely to meet likeminded entrepreneurs concerning innovativeness. This may induce a self-reinforcing innovative pattern in thick RISs having potential long-term effects for both the entrepreneurial community and for each single entrepreneur as such.

Limitations and Future Research

The RIS concept is multidimensional or in nature, embodying features of industry structures, urbanization and knowledge bases. Future studies should accordingly aim to disentangle the RIS concept and aim to identify if different regional features may have genuine and diverging effects on entrepreneurial innovation and growth ambitions. A viable approach is to apply a multilevel research design covering numerous economic regions on a national or international scale. Multilevel studies on mature firms have shown that different facets of regional industry structures and urbanizations have diverging effects on enterprises' innovativeness and productivity (e.g. Aarstad, Kvitastein, and Jakobsen 2016), and we call for similar studies on entrepreneurial firms. A possible reason for H2's lack of empirical support may be that genuine facets of potential regional drivers of entrepreneurs' growth ambitions have been masked in the current study.

Despite using a perceptual measure of innovation, we cannot see that the respondents in either thick or thin RISs would have particular incentives to report biased responses. We, therefore, argue that our empirical support for H1 is a function of a genuine higher degree of entrepreneurial innovativeness in thick vs. thin RISs. We have moreover framed the respondents with Eurostat's broad definition of enterprise innovation. To further validate the findings of this study, future research should nevertheless aim to apply other measures of innovation, such as patent counts, patent citations, or other approaches described in the literature. In a similar vein, research should aim to assess not merely entrepreneurs' growth ambitions, but also de facto entrepreneurial growth as well as other entrepreneurial performance measures.

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Article III

Differentiated Regional Entrepreneurial Discovery Processes: A Conceptual Discussion and Analysis of Three Emergent Clusters in Norway[1]

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Abstract

This paper aims to contribute to better understanding of entrepreneurial discovery processes and regional industrial growth by examining (a) how different regional contexts affect entrepreneurial discoveries, and (b) how entrepreneurial discoveries support specific types of industrial path development in different regions. The paper includes empirical studies of the formation and growth of three 'official' regional clusters supported by Innovation Norway's programme for immature clusters. The paper argues that entrepreneurial discoveries should be institutionalised (by system-level entrepreneurs) to achieve considerable regional industrial effects. In our cases, institutionalisation occurs through the creation of cluster organisations and development of the knowledge infrastructure.

Keywords: entrepreneurial discovery process, entrepreneur, regional innovation system, path development, regional cluster, Norway

[1] This article is slightly modified from the one in resubmission.

I. Introduction

The need for creating more jobs to fight unemployment and social exclusion is evident in nearly all countries and regions in Europe and beyond. The question of how growth and jobs can be created by politics is high on the research agenda. One recent approach in economic geography regards the creation of new industrial paths as an answer to the need of new jobs (Martin & Sunley, 2006). The present paper departs from this approach. It contributes, however, to the literature by focusing on how different types of entrepreneurs through entrepreneurial discovery processes can affect specific path developments in different regional settings.

A regional industrial path is materialised as a set of firms in a region that are related through a value chain, joint input factors, or utilisation of similar technologies. Firms' activities are supported by a regional innovation system of knowledge organisations and formal and informal institutions and/or are linked to extra-regional knowledge sources (Binz, Truffer, & Coenen, 2015). An industrial path lasts for some time as these are characterised by the persistence of regional industrial or institutional structures, and by the fact that economic agents continue their behaviour under changing external conditions (Henning, Stam, & Wenting, 2013, p. 1352).

New growth paths are often strongly rooted in the existing regional economic structure: 'the local inherited knowledge and skill base of an industry can form the basis of the rise of related new local paths of industrial and technological activity' (Martin, 2010b, p. 19). This focus on historically developed skills and industrial structures is a reminder of the fact that regions cannot easily, or at all, develop any kind of new industries and growth paths. Most regions cannot, for example, replicate initiatives and growth found in dynamic high-tech clusters. The importance of existing knowledge, skills, and configuration of regional innovation systems (explained below) implies that individual regions hold different preconditions for initiating new growth paths (Isaksen & Trippl, 2016).

Regionally specific entrepreneurial discovery processes

New growth paths are initiated, according to Foray (Foray, 2015), by an entrepreneurial discovery made by an individual entrepreneur, a firm, a regional leader, etc. The discovery includes, for example, an innovation or an institutional change. 'Entrepreneurial discovery is the essential phase, the decisive link that allows the system to reorient and renew itself' (p.

24). Entrepreneurial discovery processes also contain the demonstration by an entrepreneur or a firm that, for example, a new production process, is possible. Demonstration supports the spillover of the entrepreneurial knowledge to more economic actors, the entry and agglomeration of similar and complementary firms, and as a result, some form of industrial and structural changes that can stimulate new growth paths (op. cit.). If we extend this line of thinking, a successful entrepreneurial discovery will result in the creation of new knowledge for a region, which can initiate new economic activities and further development of the regional innovation system.

An entrepreneurial discovery should be seen from a broad perspective (Asheim & Grillitsch, 2015). A discovery that eventually leads to new activities and system changes can be made by individual actors (including entrepreneurs), firms, organisations (such as universities), and agencies (for example regional development agencies). The importance of these actors is assumed to differ between regions. We also expect the entrepreneurial discovery process to occur in different ways and to different extents in various regions. This reflects the fact that 'in general, entrepreneurial discoveries relate to existing structures and local knowledge' (Foray, 2015, p. 29). Rodríguez-Pose and Wilkie (2015) also argue that formal and informal institutions represent the context within which entrepreneurial discovery and economic activity occur. Because 'informal institutions are context and geography specific' (Rodríguez-Pose, 2013, p. 1040), they vary across regions. Regions with 'a sound institutional context seemingly provide the optimal setting for the entrepreneurial discovery process' (Rodríguez-Pose and Wilkie, 2015, p. 20). When institutions function well, entrepreneurial discovery occurs more or less automatically, i.e. not hampered by institutional constraint (op. cit.). Weak institutional contexts, on the other hand, hardly support entrepreneurial discoveries.

This paper aims to contribute to the existing literature on entrepreneurial discoveries and regional industrial development in three ways. First, it aims at a better understanding of how different regional contexts affect entrepreneurial discoveries. Second, the paper links conceptually regional contexts, entrepreneurial discoveries, and regional industrial path development. Third, it tries out *one* approach for studying entrepreneurial discoveries by focusing on key actors and regional innovation system changes that initiate cluster building processes.

The rest of the paper is organised as follows: Section 2 discusses and links the three main theoretical building blocks of the paper: entrepreneurial discovery, regional innovation

systems, and regional industrial path development. Section 3 presents the empirical context and data material for the empirical analysis of three emerging regional cluster projects in Norway. Section 4 examines the relevance of the conceptual framework developed in section 2 through empirical studies of the entrepreneurial discovery processes underlying the emergence of the three cluster projects. Section 5 concludes by discussing general theoretical lessons from the study.

II. Analytical framework: Regionally differentiated entrepreneurial discovery processes

The paper proposes an analytical framework that links regional context, entrepreneurial discovery processes, and regional industrial path development. The framework advances the idea that entrepreneurial discoveries occur differently and tend to result in different outcomes in specific types of regional contexts.

Entrepreneurial discovery processes

The first building block in the analytical framework is the entrepreneurial discovery process. Entrepreneurial discoveries are traditionally understood as individual entrepreneurs' actions in competitive markets. The discovery process is then characterised by 'routine-resisting' and risk-taking entrepreneurs, which discover and anticipate opportunities for profit that appear in a market (Kirzner, 1997). The first-comers, however, meet competition from other entrepreneurs. The entrepreneurs challenge others by offering the best products in rivalrous processes and by depending on 'the incentives provided by the possibility of pure entrepreneurial profit' (Kirzner, 1997, p. 73).

Debates about entrepreneurship and innovation activity in the 1980s and 1990s contributed to a change in the understanding of entrepreneurial discovery processes *from* driven by individual firm entrepreneurs *to* also including social and economic structures surrounding entrepreneurship and innovation (Lundvall, 1992, 2007; Porter, 1998; Spigel & Harrison, Forthcomming). We draw two lessons from this interpretation of entrepreneurship that are particularly relevant for the conceptual framework in this paper first, that several contextual factors affect entrepreneurship processes and, second, that entrepreneurship is also performed by actors other than those individuals who establish new firms or substantially change existing firms. The first understanding corresponds to Spigel's (2013) point that

'entrepreneurship is a social endeavour embedded in multiple cultural and economic contexts' (p. 804), and that 'entrepreneurs largely draw on local resources as they start and grow their firms' (p. 807). We use the concept of regional innovation systems to examine the importance of contextual factors for entrepreneurial discoveries, as further developed below.

It follows from the first point that entrepreneurship involves more actors than those who start new firms or initiate innovation activities in existing firms. It also includes actors who provide complementary assets, develops innovation support structures, are demanding customers, etc. (Garud & Karnøe, 2003). Thus, entrepreneurial discoveries may include a variety of stakeholders that explores, experiments, and learns what type of investments should be taken to obtain innovation and competitive advantage (European Commission, 2012).

In line with this broad perspective on entrepreneurial discovery, we distinguish analytically between two types of entrepreneurs, i.e. firm-level entrepreneurs and system-level entrepreneurs. Firm-level entrepreneurs are individuals who start new, innovative firms or who carry out innovation activities in existing firms, whereas system-level entrepreneurs are able to change the framework conditions or the 'wider settings' (Edquist, 2005) that affect industrial development within a specific region and industry. System-level entrepreneurs are quite similar to what Sotarauta and Pulkkinen (2011), among others, denote as institutional entrepreneurs, who are individuals, organisations, or groups of actors who 'mobilize resources, competence, and power to create new institutions or to transform existing ones' (Sotarauta & Pulkkinen, 2011, p. 98). Institutions, in the meaning of 'taken-for-granted, culturally embedded understandings' (Garud, Hardy, & Maguire, 2007, p. 958) change slowly and thus tend to support the continuity of an industry. Institutional entrepreneurs may be of different types, such as policy-makers, politicians, university leaders, and firm leaders. A common characteristic is 'capacity to reflect and act in ways other than those prescribed by taken-for-granted rules' (p. 961).

Regional innovation systems and system-level entrepreneurs

Our outlining of the concept of system-level entrepreneurs departs from the regional innovation system (RIS) approach. A RIS consists of two subsystems underpinned by an institutional infrastructure (Asheim & Isaksen, 2002; F. Tödtling & Trippl, 2005). The subsystems contain a region's industry (firms, entrepreneurs, clusters) and its knowledge infrastructure of universities, R&D institutes, incubators, etc. The institutional infrastructure

includes ‘formal regulations, legislation, and economic systems as well as informal societal norms’ (Gertler, 2004, p. 7) that stimulate or hamper knowledge flow and innovation cooperation within and between actors in the subsystems.

Regional innovation systems support innovation and competitiveness of key regional industries. But strong RISs are also ‘prone to lock-in and path dependency and largely geared to generate incremental innovations and gradual change’ (Boschma, Coenen, Frenken, & Truffer, 2017, p. 36). Following this line of thought, strong RISs often hamper new areas of entrepreneurship for a region. We, therefore, argue that entrepreneurial discovery processes need both firm entrepreneurs and adaptation and development of RISs so that they support new, emerging, and transformed industries and not only back the extension of existing regional strongholds. If an entrepreneurial discovery is to result in new growth paths, the innovation system should be developed and better adapted to the need of new activities.

In principle, reconfiguration of RISs to support entrepreneurship and innovation in new, regional industries can be of three main types (Miörner & Trippl, 2017). First, new institutions, organisations, and policy instruments can be created (layering). Second, existing institutions, organisations, and policies can be adapted to better fit emerging industries (adaptation).Third, existing institutions, organisations, and policy instruments can be used in new ways (novel application). We interpret system-level entrepreneurs as individuals or organisations who are able to bring about such changes in RISs[2]. Following this line of thought, new growth paths or major path changes are initiated by firm entrepreneurs who introduce new activities in a region *at the same time as* the innovation system is further developed or restructured by system-level entrepreneurs.

The literature contends that different types of RISs have different potentials to support entrepreneurship and innovation in new areas (Isaksen & Trippl, 2016). The potential depends in particular on the learning opportunities stemming from combinations of different types of knowledge, which is supported by cognitive and geographical proximity between actors (Frenken & Boschma, 2007). The paper distinguishes three types of RISs that are supposed to have different potentials for interactive learning, entrepreneurship, and innovation. The distinction applies to the number and variety of RIS actors: firms, industries, and knowledge

[2] The concept of social entrepreneurs has some similarities with our definition of system-level entrepreneurs. Social entrepreneurs act to create and sustain social value; an innovative solution ‘to address unmet social needs, so that large scale benefits for society are generated’ (Petrella & Richez-Battesti, 2014, p. 150). In a sense, system-level entrepreneurs also work for the benefits of society, but in a much more restricted influence area of RISs.

and support organisations present in a region. This decides the number of regional actors with different knowledge that *can* participate in knowledge exchange and entrepreneurial discovery processes.

The three different types of RISs include organisationally thick and diversified RISs, organisationally thick and specialised RISs, and organisationally thin RISs (Isaksen & Trippl, 2016). Organisationally thick and diversified RISs are characterised by the presence of a relatively large number of different firms, a heterogeneous industrial structure, and several knowledge and supporting organisations that facilitate innovation in different economic and technological fields. This type of RIS is most often found in large core regions, such as metropolitan areas and advanced technology regions.

Organisationally thick and specialised RISs host strong clusters in one or a few industries only, and knowledge and support organisations are first of all tailored to their narrow industrial base. These RISs are typical for old industrial areas and industrial districts. Compared with thick and diversified, these RISs are supposed to have poorer conditions for entrepreneurial discoveries and more possibilities for lock-in of existing industrial strongholds (Grabher, 1993). Organisationally thin RISs have only a few knowledge and support organisations and none or weakly developed clusters. Such characteristics are often found in peripheral regions. Owing to relatively few local actors and little local knowledge flow, actors with external knowledge links or in-migrants are assumed to be important in entrepreneurial discovery processes in organisationally thin RISs.

Path development

The third building block in the analytical framework includes possible outcomes of the entrepreneurial discovery in the form of different regional industrial paths. Path development theory maintains that future industrial development follows certain pathways anchored in and influenced by history (Arthur, 1988, 1989; David, 1985; Martin & Sunley, 2006). This paper distinguishes three different paths: path extension, path renewal, and path creation (Neffke, Henning, & Boschma, 2011).

Regional path extension consists of ‘incremental product and process innovations in existing industry and along prevailing technological paths’ (Isaksen, 2015, p. 587). Because of the lack of inflow of new, supplementary knowledge, the innovation potential of a regional industry

can gradually drop to a level where the industry may stagnate, decline, and eventually disappear (Martin, 2010a; Tödtling &Trippl, 2013).

Two types of new path developments are pinpointed here: regional path renewal and path creation. Regional industrial path renewal consists of industries branching into new but related sectors (Boschma, Frenken, Bathelt, Feldman, & Kogler, 2012). This industrial mutation process is based on the linking of knowledge and skills in different existing firms and industries, which results in new, economically relevant knowledge. Existing resources and technology allow and restrain the possible outcome of the path renewal, and regions are, therefore, 'most likely to branch into industries that are technologically related to the pre-existing industries in the regions' (Neffke et al., 2011, p. 237).

The most comprehensive way to regional industrial change is the creation of a new regional industry. New regional paths can develop when firms and industries are transplanted into a new region or through the commercialisation of knowledge and competence already developed and existing in the region (Tödtling & Trippl, 2013). One should, however, account for the fact that entrepreneurs and firms can come up with radical new ideas that do not relate to prior knowledge and skills in a region. As discussed above, such ideas must still meet some kind of support in the existing or updated RIS to initiate a totally new regional industrial path.

Analytical framework

Table 1 links the three conceptual building blocks and hypothesises about who can be key actors in entrepreneurial discovery processes in different types of RIS, about major changes arising from entrepreneurial discoveries and which are different between the three RISs, and possible path development in each case. Empirical studies point to the fact that thick and diversified RISs demonstrate considerable economic dynamism and higher rates of firm formation than the two other regional types (Duranton & Puga, 2002; M. P. Feldman & Audretsch, 1999; Fritsch, 2011). We, therefore, expect firm-level entrepreneurs to initiate many entrepreneurial discoveries in thick and diversified RISs. Regions with thin RISs are far less dynamic (Petrov, 2011). They generally have fewer innovative new firms than thicker RISs (Fritsch, 2011), and we, therefore, expect system-level entrepreneurs, such as actors in the support system, to be relatively more important in thin, and also in specialised RISs, than the thick and diversified ones.

A RIS change can be of two main types. First, it may involve new or changed organisations, i.e. the establishment of new organisations (such as an incubator) or changes within existing organisations (such as a new study programme;) (Miörner & Trippl, 2017). A second type involves new or changed relations between the organisations, such as increased knowledge flow and interactive learning between firms and universities (Lundvall, 2007).

Thick and diversified RISs have a variety of knowledge actors and firms. However, a fragmented and complex system may hamper knowledge flow (Tödtling & Trippl, 2005). The strengthening of knowledge links is therefore particularly relevant in thick and diversified RISs. This also applies in thick and specialised and thin RISs, in which knowledge links to extra-regional actors are particularly important (op. cit.). Thin and thick and specialised RISs have by definition few knowledge organisations or organisations within a narrow area of knowledge. Increased regional knowledge exchange therefore demands new and/or adapted knowledge creating and diffusion organisations, whereas such organisations are more often already in place in thick and diverse regions.

The entrepreneurial discovery process can lead to different regional industrial path development in the three types of regions. Thick and diversified RISs are best suited to support path creation, whereas the two other types of RISs primarily strengthen path extension (Isaksen & Trippl, 2016). Table 1 is mainly a focusing devise: 'It helps to organise and focus the analysis, it helps to foresee what is going to happen, it helps to explain what has happened and it helps to give basis for rational action' (Lundvall, 2007, p. 99). Thus, the analytical framework in Table 1 guides the empirical investigations of entrepreneurial discovery processes in three evolving cluster projects.

Table 1. Linking of different types of RISs, entrepreneurial discoveries, and regional industrial path development.

Type of RIS	**Characteristics of entrepreneurial discovery processes**		**Possible regional industrial path development**
	Key entrepreneurs	*RIS changes*	
Thick/diversified Thick/specialised Thin	↓ Increasing importance of system-level entrepreneurs	↓ Increasing importance of new and adapted knowledge creating and diffusion organisations	Path creation and renewal Path extension and renewal Path extension

The investigation of the three cluster projects aims to explore the relevance and usefulness of the conceptual framework in Table 1 in empirical studies. The objective is not to assess if, for example, entrepreneurial discovery processes are initiated by system-level entrepreneurs in all thin RISs, but rather to consider to what extent firm-level and system-level entrepreneurs are useful conceptual categories in empirical studies. The result of this 'empirical test' can be that the conceptual framework is a useful starting point to study entrepreneurial discovery processes in different regional contexts, or that the framework needs to be revised to a greater or lesser extent in subsequent, related studies.

Based on this line of thought, three types of questions for the empirical analyses of the evolving cluster projects emerge from the conceptual framework:

1. Is the distinction between firm-level and system-level entrepreneurs useful, and do system-level entrepreneurs tend to be increasingly important in thin vs. thick RISs?
2. Is the establishment of new knowledge creating and diffusion organisations vital in distinguishing between entrepreneurial discovery processes in various RISs? Does the establishment of such organisations tend to be increasingly important in thin vs. thick RISs?
3. Is it useful to explore the results of entrepreneurial discovery processes as different path developments? If so, do path changes tend to be less radical in thin vs. thick RISs?

The reasons for choosing the study objects and how the empirical studies have taken place are justified below.

III. Context and method

This paper aims to discuss and further develop the conceptual framework by use of relevant empirical data. The data should ideally include examples of entrepreneurial discovery processes in the three types of RISs discussed above. Based on previous research on the development of regional clusters in Norway, we decided to study the growth of three so-called Arena cluster projects as possible manifestations of entrepreneurial discovery processes.

Arena is a cluster programme run by Innovation Norway to support the further development of immature clusters or agglomerations of firms that can increase competitiveness through

cluster building activities[3]. Emerging clusters achieve Arena status through an application to Innovation Norway[4], where just a few applicants succeed each year. The application requires a substantial local mobilisation of firms and, often, knowledge organisations. Local actors must agree on, commit to, and start some common activities such as joint competence building, marketing, or innovation projects. The work by actors to obtain the status as an Arena cluster and the first cluster building were considered as possible materialisations of entrepreneurial discoveries (based on, among others, Holmen & Fosse, 2017).

The three selected Arena projects are located in different labour market regions that, to some extent, coincide with the three types of RISs described above. Oslo Edtech (education technology) is located in the thick and diversified Oslo region[5]. Oslo is by far the largest labour market region in Norway with more than 650,000 inhabitants. The region is specialised in knowledge based services with a location quotient around 2.4 in information and communication (section J in ISIC Rev. 4) and financial and insurance activities (section K), and about 1.7 in professional, scientific and technical activities, and real estate activities (sections M and N). The cluster organisation has approximately 40 members, which are mostly small and new firms that are developing new learning programmes (Table 2).

Although the Oslo region constitutes a thick and diverse RIS, the other two regions, Molde and Hamar, are more difficult to categorise. The traditional manufacturing industry region of Molde with 65,000 inhabitants is located on the west coast of Norway. The region specialises in manufacturing (section C) with a location quotient of 1.5. Molde is part of Møre and Romsdal County. The county includes three university colleges (of which one has recently become part of the Norwegian Technical University in Trondheim), four R&D institutes, and five cluster projects in the Norwegian Innovation Cluster programme. Hamar, with approximately 91,000 inhabitants, is located in eastern Norway. Hamar has no distinct industrial specialisation beyond agriculture, forestry, and fishing (section A) with a location quotient of 1.6. Hamar is part of Hedmark County. This county includes one university college, one research institute, and one cluster project, i.e. Arena Heidner, analysed in this article. Hedmark is thus much thinner than Møre and Romsdal in the number of knowledge

[3] Link to the Arena programme home page: http://www.arenaclusters.no/the-arena-programme/
[4] 'The Norwegian Government's most important instrument for innovation and development of Norwegian enterprises and industry' www.innovasjonnorge.no
[5] We refer to economic regions as defined by Statistics Norway (Hustoft et al. 1999), and which resemble labour market regions.

organisations and clusters. Actors in RISs often use extra-regional knowledge for innovation purposes. Firms in Hamar, such as those belonging to the Heidner cluster can, and do, cooperate with knowledge organisations in the Oslo area. Molde is farther from Oslo, but geographically closer to the Norwegian 'technological capital' of Trondheim. Based on this, we categorise Molde as part of a thick and specialised RIS and Hamar as part of a comparably thinner RIS.

The Arena cluster project iKuben in Molde includes nearly 40 firms in different sectors that aim to develop competence and activities in industrial Internet including big data, sensors, and automatization (Table 2). The member firms are both large, traditional manufacturing firms, new firms and the regional university college, and a regional R&D institute. The core of Heidner in Hamar consists of three old, R&D-intensive firms that breed livestock and refine crops, and three or four spinoffs from these: all with considerable international sales. The cluster organisation has nearly 40 members that are all part of the value chain within agricultural production from R&D activity to the cooperatively owned manufacturers and market players.

Table 2. Characteristics of the empirical cases.

Cluster name	Oslo Edtech	Ikuben	Heidner
Type of RIS	Thick and diversified	Specialised	Thinner
Main type of firms	New, small firms in an emerging industry	Cross industry manufacturing firms introducing new technology	R&D based, old agricultural firms and few spinoffs

The data employed in the analyses of the entrepreneurial discovery processes in the clusters are of three types. First, we obtained available information about the clusters and their members from home pages, applications to the Arena cluster programme, newspaper articles, and databases with firm figures. Second, and most important to this paper, interviews were carried out with 5, 4, and 5 informants in Oslo Edtech, iKuben, and Heidner, respectively. The informants included persons actively involved in initiating the cluster projects and currently leading or participating in the projects. Several of the informants are also firm leaders. The interviews involved discussions about the emergence and running of the cluster projects, key

persons involved in initiating the clusters, main activities performed, and important changes in the activities of firms and knowledge organisations triggered by the cluster projects.

Third, an Internet-based survey to firm members of the cluster organisation was carried out to gather additional information about firms' activities. Its questions include basic information about the firms, the firms' innovation activity and learning processes, and the firms' use of the cluster organisations. New firms were queried about the entrepreneurs' education and former careers. Surveys were sent to 74 firm members of the three cluster organisations. Forty-four firm members replied. The sample itself demonstrates a vast difference between Oslo Edtech, which is dominated by new firms, Heidner with far fewer and older companies, and iKuben, which occupies a middle position.

IV. Empirical analyses

Departing from our three cluster projects, we set out to explore who, firm-level vs. system-level entrepreneurs, initiated the cluster building processes before moving on to analyse the RIS changes and potential path development outcomes.

Initiating actors of the entrepreneurial discovery process

The Oslo Edtech cluster was initiated by ICT Norway (an interest organisation) and the leader of the StartupLab at Oslo Science Park. ICT Norway experienced a growing interest in educational technology, but because of its status as an interest organisation, it needed a platform where the *'the goal was to exploit the growing number of companies and their growth potential'* (Firm L). In its early start, Oslo Edtech saw the digital development within education as an opportunity to pave the way for a new industry in Norway, as *'… many edtech firms came there [Startup-Lab], they saw the need to gather these'* (Firm B). The vibrant and dynamic industrial structure in Oslo provided the foundation for establishing a business network in 2015 to '*…support development, commercialisation and export of Norwegian educational technologies'* (Oslo Edtech, 2017). Owing to their motivation for creating opportunities for a new industry, initiators of Oslo Edtech functioned as system-level entrepreneurs.

The initiator of iKuben may be characterised as both a firm-level and system-level entrepreneur. The initiator was the owner and leader of a local family firm that aimed to increase knowledge in a specific field by finding companies with similar challenges. Thus,

unlike Oslo Edtech the initial plan was not to create a cluster project, but rather to increase firm collaborations in the region. The initiator had experienced, through a network project organised by the large research institute SINTEF, how synergies can be created when firms share challenges and experiences with each other. The initiator was also the chairman of the board at Molde Industry Forum[6]. The cluster itself came about by slowly sharing the idea of the advantages of collaboration. In the words of the initiator, '*… we continued to spread the idea in meetings with certain firms, which we considered to be firms we had an occupational, professional, and close relationship with.*' Since then, more actors have joined the network, and a cluster project was started in 2012.

When it comes to Heidner, the initiators were leaders at the knowledge park and in established firms. Their main motivation was to revitalise and formalise already existing collaboration, making them system-level entrepreneurs. Before Heidner, the biotech milieu had an Arena project in 2003. The rationale for sparking new life into old structures of collaboration was twofold. First, the region would benefit from a continuation and an extension of biotech knowledge sourcing activities, and second, a new official cluster organisation would be able to once again apply for funding and other support from the Arena programme. Because most of the invited firms shared a long history of formal and informal collaboration, all firms accepted the invitation to participate. Within a few months, the newly born cluster applied for Arena status, which was granted in 2012.

Our cases demonstrate that the distinction between firm-level and system-level entrepreneurs is applicable and relevant to empirical studies, and entrepreneurs can be distinguished by their motivation and action. The distinction may help us substantiate our understanding of how entrepreneurial discovery processes start. System-level entrepreneurs are important initiators in all cases, whereas start-up entrepreneurs have been essential only in the Oslo Edtech case.

RIS changes

Beyond distinguishing between the initiating actors, this paper explores if we could find any changes in the regional innovation system that pertain to the establishment of new knowledge creating and diffusion organisations or to new relations between organisations. The empirical studies registered RIS changes in all three cases. Most prominent in the Oslo Edtech cluster is

[6] An independent and unpolitical interest organisation created to coordinate local interests in different industries and professions.

the establishment of several new firms in a new industrial sector for the region. The survey demonstrates that new edtech firms in Oslo are often small (with 10 employees and less) and often have local entrepreneurs who have already worked in the Oslo region. In general, the entrepreneurs have higher educations and various job backgrounds, but several come from the ICT or education sectors.

Regarding other RIS changes, the Oslo Edtech cluster organisation managed to prioritise edtech as an area for innovation projects for the period 2016–2019 at the Regional Research Fund for the Capital region[7]. The close proximity to, and collaboration with, the Norwegian Business School's learning lab seems to be advantageous for innovation processes in the firms. The survey also points to the importance of experience based competence in the firms (ranked as very important for firms' core competence by 87% of the respondents). The survey also pointed to high importance of ideas and knowledge from customers in innovation processes (60% of the firms regard customers as very important knowledge sources for product and service innovations, 40% as somewhat important). The Oslo region is advantaged by its proximity to many customers and good possibilities to recruit relevant workers.

Over time, iKuben firms have strengthened their collaboration with Molde University College. At the beginning of the collaboration in iKuben, one firm asserted that, *'…in many ways [the University College] seemed more interesting to work with […] an institute in Canada or someplace else in the world, rather than connecting to the regional business life. We [the cluster organisation] have challenged this a lot, to say the least' (Firm C).* The cluster organisation also increased collaboration with other Norwegian clusters and, in the process, tried to develop their own special competence area in future business modelling (Firm C). The 'future business modelling' priority is supported and facilitated by the Protomore innovation lab, established on behalf of iKuben as an early prototype lab for innovative and emerging business ideas. *'Due to the downturn in the oil and gas sector, the need of restructuring is vast among our firms. At the same time, we face both digitalisation and green shifts. The lab is the most important thing we have at the moment' (Firm F).* Since its establishment, the lab has hosted more than 60 workshops with more than 900 participants from the industry.

[7] Source: Home page of the Research Fund: http://www.regionaleforskningsfond.no/prognett-hovedstaden/Om_fondsregion_Hovedstaden/1253953954563

The iKuben cluster organisation has also contributed to increase collaboration between firms: *'…even though we develop and deliver quite different products and services, …how we improve and develop our business models is as relevant for us as any other firm in the cluster' (Firm E).* The collaboration materialised in 10 cross-industry R&D projects during the cluster organisation's first year. One idea behind the iKuben project portfolio was to create a 'bank of challenges,' where all firms entered the challenges they thought might be suited for joint projects. Even so, the survey demonstrates that, by far, the most important sources of knowledge in innovation processes are customers, who are most often national and international ones. (In all, 79% of the firms regard customers as very important sources of knowledge for product and service innovation, and 21% regard them as somewhat important. Further, 84% of the most important knowledge sources are found outside Møre and Romsdal).

Heidner's history of knowledge sourcing activities and collaboration between firms' R&D departments has its roots in the 1960s, and '*core companies in Heidner have developed spin-offs that deliver services to these firms' (Firm G).* The survey also demonstrates that Heidner firms are comparatively R&D-intensive, both through R&D activities in firms and through collaboration with universities, university colleges, and R&D institutes. (Forty-three per cent of the firms regard systematic R&D activity as very important for developing their core competence, and another 43% regard it as somewhat important. Likewise, 43% of the firms report that cooperation with universities, R&D institutes, etc., is very important for product and service innovation, and 43% regard it as somewhat important.

The research-intensive firms in Heidner have been a driving force in the development of research and education in biotechnology at the Hamar campus of the Innland Norway University of Applied Science. A result of the tight collaboration between the university and firms is the launch of a master's programme in industrial biotechnology, in which '*students base their thesis on industry related challenges (and) will learn not only about applied biotech but also about commercialisation and other business related issues' (Firm K).* Employees in local biotech firms contribute as supervisors for the master students, and because many firms hold their own staff of researchers and PhD students, they add to the local academic milieu within the field.

Heidner firms often participate in projects with national and international universities, which have helped increase firms' national and international knowledge links. Finally, Heidner firms have increasingly linked their specific expertise to university research milieus at the national

technical university, Norwegian University of Science and Technology in Trondheim, and the Norwegian University of Life Science, close to Oslo. The cluster is also establishing links to a completely different field of gaming technology with a growing number of gaming firms in the Hamar region, and '*their advanced technology is used in several joint projects at the moment' (Firm H).*

RIS changes are found in all three cases. In particular, these include changes pertaining to the establishment of new knowledge-creating and -diffusion organisations, exemplified by the Protomore lab in iKuben and the industrial biotech master's programme in Heidner. The establishment of such organisations seems more important for iKuben and Heidner than for Oslo Edtech. This is because a relevant knowledge infrastructure, including the BI Innovation Lab, was already well established in Oslo, whereas a relevant knowledge infrastructure was more limited in the other two regions. Therefore, the major RIS change in the Oslo Edtech industry includes several start-ups and the development of knowledge links between these and existing organisations.

Regional industrial path development

Finally, the empirical analyses deal with possible outcomes of the entrepreneurial discovery process in the three cases. First, we inquire whether or not it is useful to explore the results of entrepreneurial discoveries as different path developments, and second, whether or not our case study provides evidence to support the theoretically based suggestion that path changes are more radical in thicker RISs than in thinner RISs.

We find it useful to explore the result of entrepreneurial discovery processes as different path developments. This adds a 'qualitative dimension' to the analysis, because the use of the path approach allows us to suggest the significance of the entrepreneurial discovery process on the overall regional economy. Examples are the expansion of existing industry or greater renewal of the industrial structure. Above, we demonstrated that RIS changes vary in their degree of radicalism between the three cases, because some changes involve more of the same, whereas others include the establishment of new ventures within an industry not already present in the region.

Firms in the Oslo Edtech cluster are developing and introducing a new technology into a growing market. This market-expanding process has escalated into a regional agglomeration

of related initiatives, including to create a supporting regional industrial infrastructure and policy support. The introduction and growth of the education technology milieu in Oslo indicates a possible start of new path creation in the region.

The cross-industry entrepreneurial discovery process of iKuben illustrates a more customer-driven process of innovation and change. Experiencing increased competition and more demanding customers, local, non-competing firms intensified their cross-industrial collaboration to share experiences and develop new knowledge to achieve improved quality and reduce costs, which mostly support path extension. However, some of the recent partnership initiatives may result in more industry renewing innovations and thus pave the way for regional industrial path renewal. The initiatives include collaborations focusing on the use of AR (augmented reality) and VR (virtual reality) technology in new and related areas.

Finally, the entrepreneurial discovery process at Heidner serves as an example of an industry path extending initiative. The breeding of animals and plants is a time-consuming process evident from a long line of continuing minor adjustments. Building mainly on R&D-generated knowledge combinations, the cluster firms have worked together to make the various Norwegian species of animals and fish more resistant, more climate-friendly, more tailor-made to customers' needs, and to make the breeding process more streamlined and cost-efficient. Some new initiatives have been taken to merge new and unrelated gaming technology, but the practical use of this technology still focuses on the same fundamental question of how to make production more efficient and how to increase the quality of the breeding process. Overall, the three empirical cases resonate well with the conceptual framework that indicates a possible relationship between regional thickness and diversity and radicalism of path changes.

V. Conclusions

This paper describes conceptually the links between different RISs, entrepreneurial discovery processes, and new path development. The relevance of the analytical framework is discussed through empirical studies of three Norwegian cluster-building projects. The empirical discussion is guided by three sets of research questions emerging from the conceptual framework.

Regarding the first question, we find that the distinction between firm-level and system-level entrepreneurs is productive in conceptual terms and in empirical studies. The cases demonstrate that system-level entrepreneurs have been vital to the initiation of the entrepreneurial discovery process in all cases. Of the three cases, Oslo Edtech has most firm-level entrepreneurs as found in several start-up companies. The Edtech case has also relied on system-level entrepreneurs to create an organisation that increases firm collaboration and policy support. This is a reminder of the role of system-level entrepreneurs in entrepreneurial discoveries and cluster-building processes, as well as in dynamic core regions where the role of firm entrepreneurs as 'change makers' is often highlighted (M. Feldman, Francis, & Bercovitz, 2005).

Second, we find that changes in the RISs are part of the entrepreneurial discovery process, and that institutionalisation of the process is important for further cluster building. We also find that the establishment of new knowledge creating and diffusion organisations is a distinguishing factor between the cases. New or adapted organisations are found in the Heidner and, in particular, in the iKuben cases, which is in line with our conceptual framework. However, we do not maintain that the establishment of new knowledge organisations is always more important in the entrepreneurial discovery process in thick and specialised and thin RISs. Finally, our case studies demonstrate that the establishment of new knowledge organisations is a significant RIS change to focus on in studies of entrepreneurial discover processes, and which differs between regions.

Third, we find it useful to analyse potential regional industrial path development resulting from entrepreneurial discoveries, because different path developments signify various 'qualitative changes' in the regional economy: the creation of new regional industries or the strengthening of existing ones. The case studies also point to more radical path changes in thick and diverse RISs than in the other two RIS types, which follows our theoretical arguments.

A general theoretical lesson from this paper is that many types of entrepreneurs and discoveries can lead to outcomes in terms of e.g. cluster building. However, we argue that entrepreneurial discoveries have to become institutionalised to result in a substantial industrial outcome. In our cases, the institutionalisation is manifested through cluster projects and further development of the knowledge infrastructure. Another theoretical lesson is that entrepreneurial discovery processes are instrumental in upholding regional industrial path

extension to avoid negative lock-in and path exhaustion. This is particularly important in thin RISs, where path extension is the prevailing type of path development.

Further research could advance the conceptual framework through more theoretical and empirical research. Theoretical research may include conceptual clarifications of system-level entrepreneurs, among other its distinction vis-à-vis concepts such as institutional, civic, and social entrepreneurs. Empirical research may include case studies of types of entrepreneurial discovery processes other than cluster projects to test and possibly refine the conceptual framework. At a later stage, more extensive and quantitative studies may be relevant. These studies can include examining specific theoretical propositions, such as the importance of establishing new knowledge organisations for the emergence of growth paths.

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Article IV

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Linking content and technology: on the geography of innovation networks in the Bergen media cluster

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ABSTRACT

This paper deals with the geography of innovation networks and analyses combinatorial knowledge dynamics from a single cluster perspective. Addressing firms in the media cluster in Bergen, Norway, we examine how and from where companies acquire and combine different types of knowledge for their innovation activities. The empirical analysis, which is based on structured interviews with 22 media companies, identifies two main types of cluster firms: media content providers that rely heavily on symbolic knowledge and media technology providers that draw mostly on synthetic knowledge. Even though they draw on different knowledge bases, the two types of firms are strongly interlinked in their innovation activities and source knowledge from each other. Furthermore, we find that synthetic firms constitute a gateway to the regional R&D system and that the region acts as key arena for the combination of dissimilar knowledge bases.

KEYWORDS

Innovation networks; knowledge bases; creative industries; new media; Norway

JEL CLASSIFICATIONS

L82; O14; O30; O31

1. Introduction

In economic geography and related disciplines, there is an increasing interest in the question how and from where firms acquire new knowledge for innovation. Despite the ongoing globalisation, the regional level is typically seen as key locus for interactive learning and knowledge exchange (Moulaert and Sekia 2003; Asheim and Gertler 2005). Consequently, policy-makers seek to strengthen economic competitiveness through regionally oriented policy approaches, based on concepts such as clusters, in particular by fostering networking between innovative actors, including firms, universities and public support organisations.[1] Studies on the geography of innovation networks, however, have shown that firms acquire knowledge not only locally, but from multiple geographical scales, which requires policy approaches that cross regional boundaries. Furthermore, the importance of local knowledge networks has shown to differ between industries with different knowledge base (Martin and Moodysson 2013; Plum and Hassink 2014). In addition to industry-specific differences, it has also become apparent that firms engage not only into collaborative networks, but use multiple

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[1]See, for instance, the Research Council of Norway's Programme for Regional R&D and Innovation (VRI) (RCN 2013).

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knowledge sourcing channels. While research on the geography of knowledge networks typically relies on measures of inter-organisational collaboration such as co-publications or joint R&D projects (e.g. Fitjar, Huber, and Rodríguez-Pose 2016; McKelvey and Rake 2016), research on non-collaborative knowledge exchange is relatively scarce. The question whether different network channels entail different geographies has not been scrutinised systematically, which is one research gap this paper attempts to fill.

Furthermore, while earlier literature argued that clusters are naturally dominated by either analytical, synthetic or symbolic knowledge bases (e.g. Asheim and Gertler 2005; Tödtling, Asheim, and Boschma 2013), more recent contributions stress that firms usually combine two or more knowledge bases in the innovation process (Manniche, Moodysson, and Testa 2016; Grillitsch, Martin, and Srholec, forthcoming), and that clusters can change their dominant knowledge base over time (Martin and Trippl 2015; Ingstrup, Jensen, and Christensen 2017). The combination of knowledge bases has been studied at the firm level, but may also take place at the level of a cluster. In line with that, this paper contributes with an analysis of knowledge base combinations from the perspective of a single cluster.

The empirical analysis is based on novel data collected through interviews with firm representatives in the media cluster in Bergen, Norway. The media sector is considered as artistic and cultural industry, in which symbolic knowledge, aesthetic values and design play a central role (Grabher 2002; Mossig 2004; Cooke 2010). Due to the ongoing digital convergence (i.e. the convergence of ICT and media content), however, innovation in this industry is not only about the generation of media content based on symbolic knowledge, but increasingly also about the application and development of media technologies, for which synthetic knowledge is critical. How and from where firms (in the media industry in Bergen) source and combine different types of knowledge is a key issue addressed in this paper.

The paper is structured as follows. Section 2 provides a theoretical framework by combining insights from the literature on knowledge bases, knowledge sourcing channels and proximity dimensions. Section 3 introduces the empirical case and presents the data and method. Section 4 comprises an analysis of knowledge flows and networks between firms and other organisations in the Bergen media cluster. Section 5 concludes the findings and draws implications for future research.

2. Theoretical framework: the geography of knowledge sourcing

One of the key issues in economic geography is the question why innovation concentrates in certain locations. The core argument for explaining spatial clustering of innovation activities is that the transfer of knowledge, which is the most important input for innovation, is facilitated by geographical proximity: it is easier to exchange knowledge between economic actors that are co-located, whereas additional efforts are needed to overcome spatial distance.

In this context, knowledge should not be seen a homogenous, but can come in different forms with different sensitivities to proximity and distance. A common way to classify knowledge is into codified and tacit, and while the first can be written down and easily transferred over time and distance, the latter is embodied into humans, can be best transferred though face-to-face interactions and is therefore spatiality sticky (Polanyi 1967; Gertler 2003). Although the 'tacit versus codified' dichotomy has been widely used, it tends to reinforce one of the main conceptual binaries in human geography, that is, 'local versus global'

(Cloke and Johnston 2005; Cox 2005). In line with the observation that innovation often involves both tacit and codified knowledge (Nonaka, Toyama, and Konno 2000; Johnson, Lorenz, and Lundvall 2002), innovation can equally well depend on a combination of local and global knowledge sources. Some authors stress that neither the exchange of tacit nor the exchange of codified knowledge is restricted to a particular geographical scale, as firms can use different communication channels to acquire new knowledge both locally and globally (Asheim and Isaksen 2002; Belussi and Pilotti 2002; Moodysson 2008). Others stress that geographical proximity is neither a necessary nor a sufficient condition for knowledge exchange, as other types of proximities need to be present for successful knowledge transfer (Torre and Gilly 2000; Boschma 2005).

Based on these considerations and in order to understand how and from where firms acquire and combine different types of knowledge, it is important to elaborate more on (1) the type of knowledge sourced and combined for innovation, (2) the type of knowledge sourcing channels used by firms and (3) the type of proximity between innovative actors. These three analytical dimensions are discussed in the following.

2.1. Differentiated knowledge bases and their combinations

One way to further study geographical patterns of innovation is by considering the type of knowledge that is sourced and exchanged in the innovation process. While tacit versus codified is one possible knowledge typology, the literature on knowledge bases aims at moving beyond this dichotomy (e.g. Laestadius 1998; Moodysson 2007; Gertler 2008; Asheim, Boschma, and Cooke 2011). Asheim and Gertler (2005) argue that 'the innovation process of firms is also strongly shaped by their *specific* knowledge base, which tends to vary systematically by industrial sector' (Asheim and Gertler 2005, 295, emphasis in the original). Three types of knowledge bases can be distinguished; namely, analytical, synthetic and symbolic, which differ in various respects such as the rationale for knowledge creation, the development and use of knowledge, the actors involved and the role of spatial proximity in the innovation process (Asheim, Boschma, and Cooke 2011). Innovation in analytical industries aims at the development of new knowledge about natural systems by applying scientific laws. Innovation involves strongly codified and universally valid knowledge content, which is little restricted to a specific sociocultural context. Synthetic industries innovate by applying existing knowledge in new ways. Innovation takes the form of concrete problem-solving and interactive learning with customers and suppliers. Innovation in symbolic industries aims at the creation of meaning, desire and aesthetic assets. Interpretation and cultural knowledge is essential and to a high degree determined by the sociocultural context.

The knowledge base typology has been applied to study industry-specific differences in innovation networks. Studies show clear differences between innovation networks in analytical, synthetic and symbolic industries (Plum and Hassink 2011; Martin 2013; Martin and Moodysson 2013; Herstad, Aslesen, and Ebersberger 2014). Knowledge exchange in analytical industries tends to be globally organised and include universities and other R&D organisations as important knowledge hubs. Knowledge exchange often takes place in epistemic communities and with highly specialised knowledge providers in different parts of the world. In synthetic industries, cooperation and knowledge exchange often occurs between firms in the value chain and builds on trust and reciprocity earned through repeated interactions. Relatively, little collaboration takes place over far geographical distance, while

national or regional networks prevail. Innovation in symbolic industries is even more governed by the local context, and companies cooperate with a number of altering partners in close geographical proximity. Companies change their cooperation partners frequently. They are tied together for the short period of a project before they switch to other projects and other collaboration partners. The importance of cultural knowledge and project-based innovation implies that knowledge exchange in symbolic industries takes place primarily within localised networks (Manniche and Larsen 2013; Plum and Hassink 2014).

While these findings generally hold true on an industry-level, micro-level studies stress that there exists strong heterogeneity between firms in the same industry (Srholec and Verspagen 2012). Firms in one industry may rely on different competencies and specialise into different activities. Also, similar firms can specialise on different knowledge bases to serve different clients (see, for instance, Pina and Tether 2016 on knowledge-intensive business services). In fact, combinations of knowledge bases can occur at the level of the industry and at the level of firms. This argument has been advanced in recent studies on knowledge base combinations (Manniche, Moodysson, and Testa 2016; Grillitsch, Martin, and Srholec, forthcoming). These studies indicate that even though analytical, synthetic and symbolic knowledge are distinct ontological categories, they are hardly employed exclusively and detached from other modes of innovation. In fact, innovations are often the result of diverse knowledge inputs that are combined in the innovation process. These combinatorial knowledge dynamics call for more nuanced studies on knowledge networks and the involved knowledge bases.

2.2. Knowledge sourcing mechanisms – collaboration, mobility and monitoring

The notion of knowledge bases raises the question how and from where firms access and combine new knowledge. Early work on knowledge spillover had the tendency to treat knowledge as freely roaming in the air (e.g. Audretsch and Feldman 1996), while more recent studies acknowledge that knowledge is hardly ever transferred out of pure coincidence (Moodysson 2008; Belussi and Sedita 2012). In fact, knowledge sourcing typically requires a dedicated effort, alongside with the necessary absorptive capacity to make use of that knowledge (Cohen and Levinthal 1990). In order to acquire new knowledge, firms use a number of knowledge sourcing mechanisms and engage into different types of networks. Belussi and Sedita (2012), for example, distinguish between emergent and deliberate knowledge structures. The first constitutes spontaneous and non-deliberate forms of social interaction such as social netwoks and communities of practice, while the latter include business networks and formal R&D linkages through which firms gain access to specialised complementary capabilities and/or new scientific knowledge.

A commonly observed type of knowledge relation is inter-organisational *collaboration*, where firms engage into reciprocal relationships which lead to bidirectional flows of knowledge (e.g. Fitjar and Rodríguez-Pose 2013; Herstad, Aslesen, and Ebersberger 2014; Chaminade and Plechero 2015). Collaboration networks can be of formal nature as in the case of contract-based R&D partnerships, strategic alliances or joint ventures (e.g. Balland, De Vaan, and Boschma 2013; Jakobsen and Lorentzen 2015) or they can be of informal nature, for instance, in the form of social relationships or professional communities (e.g. Grabher and Ibert 2006; Huber 2012; Lorenzen and Mudambi 2013). They manifest on the organisational level, but are often mediated on the individual level through interpersonal

relations. Huber (2012) shows that even in R&D-intensive industries, important forms of knowledge exchange do not only occur through formal collaborations, but through personal networks between skilled workers. Geographical proximity and face-to-face interactions facilitate the formation of personal relationships that subsequently lead to innovation-related collaboration between firms. In cultural and creative industries, knowledge is often exchanged in a dynamic interplay between formal project collaboration and informal social networking (Garmann Johnsen 2011). Even though the regional level plays a vital role in creative industries (Plum and Hassink 2014), collaboration is not limited to spatial proximity, but can span over long distances (Vang and Chaminade 2007; van Egeraat, O'Riain, and Kerr 2013; Manniche and Larsen 2013).

A second type of knowledge sourcing mechanism is labour *mobility*, that is, the movement of skilled individuals between organisations (Trippl 2013; Herstad, Sandven, and Ebersberger 2015). As important forms of knowledge are tacit and embodied into people, hiring skilled labour is a natural way to bring new competences to the firm. Studies that deal with the impact of labour flows on firm performance show that recruitment from the higher education system as well as from related industries in the region has a positive effect on the innovation capacity of firms (Herstad, Sandven, and Ebersberger 2015). In order to gain a positive effect on firm performance, skill portfolios of newly recruited employees should be related to the existing knowledge base of a firm, while too little, but also too much skill relatedness can have a negative impact (Boschma, Eriksson, and Lindgren 2009). In line with this, Timmermans and Boschma (2014) find that the effect of labour mobility on firm performance depends on the relatedness between the skills of current and newly hired staff. Building on the method of Neffke and Henning (2013), they find that the inflow of related skills impacts plant performance positively, while the inflow of similar skills has a negative effect. Moreover, they find that this effect depends on whether new employees are recruited from the same region or from other regions, whereby inter-regional mobility has a particularly positive effect. A number of recent studies trace the location decisions of skilled labour (Hansen and Niedomysl 2009; Niedomysl and Hansen 2010; Alfken 2015; Alfken, Broekel, and Sternberg 2015). Despite Florida's (2002) argument that skilled labour tends to move to places with attractive living conditions, empirical evidence shows that migration decisions depend primarily on job conditions in a region (Niedomysl and Hansen 2010; Alfken, Broekel, and Sternberg 2015). This even holds for creative professions, which, according to Frederiksen and Sedita (2011), are characterised by greater job mobility than other occupations. Alfken (2015) shows that inter-regional mobility is high for creative professions in an early career phase, while geographical mobility decreases in later phases of career development. These studies show that irrespective of the type of industry, labour mobility primarily depends on the job prospects in a region as well as on the life and career stage of the labour force.

A third type of knowledge sourcing channel is *monitoring*. Firms source new knowledge also through monitoring of innovation activities carried out by other organisations (Malmberg and Maskell 2002; Martin and Moodysson 2013). Monitoring can include systematic market research, the observation of customers, suppliers and competitors over various media channels (e.g. websites, social media or specialised magazines) or the attendance at trade or design fairs and exhibitions. Some monitoring activities are facilitated by spatial proximity, while others are hardly bound to specific places. Bathelt and Gibson (2013) show that firms gather in trade fairs in order to monitor competitors and partners and to source

knowledge about the latest technological developments. Trade fairs can create temporary forms of proximity (Torre 2008), which, if recurrent, can lead to more stable knowledge linkages over far geographical distance. Grabher and Ibert (2014) show that knowledge sourcing can take place via online platforms, in which interaction is mediated by virtual communication tools, and where economically useful knowledge is created and exchanged in absence of physical proximity. Martin and Moodysson (2013) argue that trade fairs and specialised magazines are important monitoring mechanisms for symbolic and synthetic industries, while analytical industries tend to use scientific journals and systematic investigations to learn about other firm's innovation activities. Furthermore, organisation studies researchers (e.g. Gioia and Manz 1985; Huber 1991) and industrial district theorists (Boari, Fioretti, and Odorici 2008; Belussi 2010) use the notion of 'vicarious learning' when referring to non-collaborative organisational learning, for example, when companies in cluster learn from rival firms and adapt their business strategies.

We argue in this paper that firms can acquire and combine new knowledge through multiple channels, each of which has different sensitivities to geographical distance. Even though the local level is considered as key arena for knowledge sourcing in particular for symbolic industries, the importance of local knowledge sourcing varies between knowledge channels. Collaboration networks are expected to be highly localised, in particular for flexible and project-based industries such as new media. The same is expected for the mobility of skilled labour, at least in regions with a decent job market and for firms that intend to hire skilled staff with job experience. Monitoring, in contrast, is expected to be less bound to spatial proximity, as firms can make use of temporary or organised proximities to overcome spatial distance.

2.3. Knowledge sourcing, knowledge bases and proximity dimensions

In order to investigate the role of geography for different knowledge-sourcing channels, it is necessary to elaborate more on the notion of proximity (Torre and Gilly 2000; Boschma 2005; Knoben and Oerlemans 2006). Proximity should be seen as multidimensional concept that goes beyond mere physical co-location. Instead, it should be understood through social and contextual factors (Sayer 1992; Morgan 2004). Knowledge exchange tends to be facilitated by short geographical distance, while at the same time, physical proximity alone is not enough to allow for fruitful knowledge exchange, if not accompanied with other forms of proximity. Building on the French Proximity School (Torre and Gilly 2000; Torre and Rallet 2005), Boschma (2005) distinguishes between five proximity dimensions, namely cognitive, organisational, institutional, social and geographical (i.e. physical) proximity. These dimensions can overlap, but also substitute one another (Hansen 2015; Menzel 2015).

Cognitive proximity refers to the idea that firms are more likely to exchange knowledge with organisations that are cognitively similar, that is, share similar routines and problem-solving strategies. Successful knowledge transfer requires absorptive capacity to identify, interpret and exploit the new knowledge (Cohen and Levinthal 1990), which is most likely to be present in firms with similar knowledge base (Mattes 2012). Boschma (2005, 63) argues that 'as a rule, firms search in close proximity to their existing knowledge base, which provides opportunities and sets constraints for further improvement'. If cognitive proximity is too small, the cooperating actors will not understand each other, which impedes

an effective knowledge transfer. But if cognitive proximity is too high, knowledge exchange will not lead to any novel re-combinations. Thus, the right degree of cognitive proximity and distance is essential for fruitful collaborations (Nooteboom et al. 2007).

While cognitive proximity is probably the most important prerequisite for fruitful knowledge exchange, also organisational, institutional and social proximity plays a role. Organisational proximity commonly refers to the degree of firm internalisation (Mattes 2012). A high organisational proximity implies that firms follow similar organisational logics or even belong to the same company group. For example, organisational proximity between private firms and public organisations would be very small, as they follow different organisational rationalities, while it would be high for firms with similar business structure (e.g. same type of small firm or new venture). Institutional proximity refers to formal institutions such as laws, rules and regulations, as well as to informal ones, that is, norms, values and routines (North 1990). Institutional proximity is what comes closest to the understanding of space in the literature on regional innovation systems (RIS), in which most arguments focus on how regional institutional settings create opportunities for innovation and knowledge exchange (Cooke 2002; Asheim and Gertler 2005). Social proximity refers to the social embeddedness of actors in terms of friendship, kinship and common experience. It is the result of shared personality traits, personal interaction and a sense of familiarity between individuals. More than any other proximity dimension, social proximity relies on trust that is built up through repeated interactions over a long period of time (Boschma 2005).

These different dimensions of proximity allow a more fine-grained perspective on the role of space for knowledge exchange and innovation. They lead to a number of research hypotheses related to the question how and from where firms acquire and combine different types of knowledge through different network channels.

- First, one can expect most knowledge exchange to take place locally, as the region is the area where geographical and institutional (and often also social) proximity is present. This is particularly important for collaboration and mobility, and less for monitoring, which does not necessarily entail interpersonal relations.
- Second, one can expect knowledge base combinations, i.e. knowledge flows between firms with different knowledge base, to take place primarily within the region, as institutional and social proximity can compensate for a lack of cognitive proximity.
- And third, one can expect knowledge exchange between firms with similar knowledge base to be less bound to the local level, as cognitive (and organisational) proximity can substitute for other types of proximity.

These theoretical considerations are investigated based on a case study on the media cluster in Bergen, Norway. As we will show, this cluster is not dominated by one knowledge base only, but by a combination of synthetic and symbolic knowledge bases.

3. Research design: a case study on the media industry in Bergen

The media industry covers a range of activities, including the generation of media content (news, music, film, etc.) and technical solutions for broadcasting and displaying media content on various devices (TVs, mobile phones, tablet computers, etc.). This paper examines how, and from where, media firms acquire and combine knowledge for their innovation

activities. As innovation is a complex social phenomenon, a case study is well suited as methodical approach to the empirical inquire, and corresponds to the preferred method of empirical inquiry within the field of regional innovation research (Asheim, Coenen, and Moodysson 2015). In the following, an introduction to the media industry in general and the media industry in Bergen in particular, is provided.

3.1. The media industry between content and technology

The key focus of the media industry is to produce and distribute media content. In recent years, technological progress opened new ways for digital communication. The ICT revolution has led to new applications and services, and today, consumers retrieve media content on a range of digital devices. Furthermore, consumers take a more and more active role in tailoring their media consumption to personal interests and preferences. As a consequence, media firms have to be present on a range of different media platforms in order to reach their customers (Groot Kormelink and Costera Meijer 2014).

This new development is a challenge to traditional media firms. In order to be successful on the market, firms need to display media content in multiple ways and on various platforms, which requires new technical competencies (Turow 2005; Groot Kormelink and Costera Meijer 2014). This development has led to an increased specialisation among media firms. Today, the media industry consists largely of companies that either specialise on the production of media content or on the provision of technological solutions related to media (Jenkins 2006; Currah 2009).

As it has been stressed in the literature, ICT and software development are dominated by synthetic knowledge (Tödtling and Grillitsch 2015), whereas the creation of media content relies mostly on symbolic knowledge (Asheim 2007; Martin and Moodysson 2011). To the extent that firms specialise on either media content or technology, they also differ in the type of knowledge base that is critical for innovation. Even though most media content providers also hold technical competences in-house, they innovate primarily based on symbolic knowledge. In contrast, media technology providers need an understanding of the creation of media content, but innovate mostly based on synthetic knowledge. In order to be active in the same industry, all firms need to possess or have access to both synthetic and symbolic knowledge, which they either hold in-house or source from other firms through different network channels (Currah 2009).

3.2. The media industry in Bergen

Bergen is the second largest city in Norway with around 275,000 inhabitants. The region has economic strongholds in the energy, the maritime and the marine sectors, as well as growing industries such as culture and media. The city serve as a knowledge hub for the western part of Norway, hosting a large and traditional university, 9 colleges, 10 research institutes and 4 official clusters organised within the cluster programme of Innovation Norway. Together with its surrounding region, Bergen can be seen as a thick and diversified RIS, with a strong research and higher education system and policy-makers that are actively engaged in innovation-based regional development (Isaksen and Trippl 2016). The local media industry took off in 1992 when national government decided to locate the headquarters of Norway's second public broadcasting channel (TV2) to Bergen. This

spurred new entrepreneurial activities and the media industry started to grow. In 1993, the first policy initiative to stimulate collaboration and knowledge transfer between media firms was established under the name of Bergen Media City. During the next decades, the size and scope of the media cluster increased continuously. In 2014, the initiative was awarded the second highest cluster status in Norway, Norwegian Centre of Expertise NCE,[2] and renamed to NCE Media. This resulted in more public-funding and expert services tailored towards increased value creation, collaboration with international partners and interaction between firms and R&D organisations.

3.3. Method and data collection

Due the diverse nature of the industry, the media cluster in Bergen is not easy to delimit. It consists of a variety of firms, of which some can be considered as pure media firms, while others serve multiple markets. Some technology-based firms, for example, are pure media software developers, while others direct only parts of their business to the media industry. This raises some methodical concerns. Firstly, as the industry boundaries are blurry, it is not possible to identify media firms from any conventional business classification scheme. Secondly, as some relevant firms are not fully committed to the media sector, not all knowledge relations are maintained for media-related activities. And thirdly, there is a potential bias related to the policy support structure. As NCE Media facilitates networking between its members, knowledge-sourcing activities can be expected to vary systematically between member and non-member organisations. Furthermore, it is also likely that long-time members are systematically distinct from new members.

In order to minimise these potential biases, this study focuses on commercial firms that have been members of NCE Media for at least one year. Accordingly, only firms that consider themselves as part of the media industry are included in the analysis. A list of member organisations provided by the cluster management included 37 qualified member organisations, from which 22 commercial firms were identified (besides 15 public and non-profit organisations). Data were collected in May–June 2015 using structured interviews with firm representatives from all 22 firms. Meetings were arranged with the CEO or a member of the top management team. The interview data were complemented with document studies on policy reports, company websites and other publicly available information. An overview of the interviewed firms is provided in Table 1.

A roster–recall method was applied to collected relational data on inter-organisational knowledge flows (for a discussion on the method, see Giuliani and Pietrobelli 2014). The interview partners were provided a list (i.e. roster) of potentially relevant organisations, including commercial firms, education and research organisations, policy support organisations and industry-relevant non-profit organisations (74 in total). Connected to the roster, the interviewees were asked to fill in additional regional, national or international organisations relevant to their innovation activities that were not mentioned in the list (i.e. recall). Relational data were illustrated and analysed using social network analysis and descriptive statistics.

[2]For more information on cluster policy instruments in Norway, see Innovation Norway (2015).

Table 1. Overview of interviewed firms.

Basic firm information	Number of firms	Percentage of firms
Located in Bergen	22	100.0
Originates from Bergen	21	95.5
Part of a corporation	15	68.2
Age > 5 years	18	81.8
Age > 15 years	11	50.0
Size < 10 employees	8	36.4
Size < 100 employees	17	77.3
Classifies itself as media content provider	14	63.6
Classifies itself as media technology provider	8	36.4
Total	22	100.0

Source:own data.

Table 2. The importance of different skills and competencies for innovation.

Firm type	Scientific skills	Engineering skills	Arts-based skills
Content provider	1.43	4.14	4.64
Technology provider	2.65	4.50	4.37
Total	1.86	4.27	4.55

Note: Importance at a scale from 1 to 5, where 1 is not important and 5 is very important. Average values.
Source: own data.

The relational data includes information on the location and the type of contact partners. The first classifies all actors in regional, national, European and global partners. The latter divides all actors into content providers, technology providers, other types of firms, universities and R&D organisations, policy support organisations and other public organisations. The interviewees specified the name and location of their contact partners as well as their importance. Company websites and business databases were used by the authors to validate and complement the names, locations and types of partners listed by the interviewees.

4. Empirical analysis: knowledge flows and networks in the Bergen media cluster

The following analysis explores the geography and organisation of knowledge networks in the media cluster in Bergen. We investigate how firms acquire and combine various types of knowledge through different network channels and from different geographical scales. We begin the analysis by identifying the types of knowledge that firms use in their innovation processes.

4.1. Combinatorial knowledge bases

To identify the knowledge bases involved in innovation, two questions were asked to the firm representatives. First, to rate (from 1 to 5) the importance of scientific, engineering and arts-based skills and competencies for the competitiveness of their firm. Second, to group their skilled employees into broadly defined education profiles, reflecting the three knowledge bases.

Table 2 shows that both symbolic and synthetic knowledge are regarded as vital for innovation by all firms. This holds equally true for media content providers and technology

Table 3. Formal education profile among media firms in Bergen.

Firm type	Scientific education (%)	Engineering education (%)	Arts-based education (%)	Other types of education (%)
Content provider	4.0	19.1	50.5	26.4
Technology provider	0.8	75.7	17.4	6.1
Total	2.7	41.9	37.2	18.2

Note: The relative number of staff holding a Bachelor's degree or above, divided into main education groups.
Source: own data.

providers. Analytical knowledge is regarded as far less important, in particular by content providers who attribute almost no relevance to science-based competencies. This demonstrates that firms in the media industry build on a combination of symbolic and synthetic knowledge for their innovation activities. However, the extent to which firms hold symbolic or synthetic knowledge in house or source it from outside varies considerably between content and technology providers.

Table 3 shows the education profiles of employees, again divided between content and technology providers. All firms have personnel with engineering and creative educational background, however, a clear difference between the two subgroups can be observed. While content providers employ mostly people with background in creative fields (50.5%) and less people with engineering-based skills (19.1%), technology providers clearly favour engineering-based skills (75.7%) over creative skills (17.4%). This finding is essential as it shows that a specialisation in firm-internal knowledge bases can be observed, in which firms focus either on symbolic or on synthetic knowledge. Thus, media firms combine different knowledge bases in their innovation process, but specialise in one knowledge base in their firm-internal education profiles.

The following analysis deals with sourcing of firm-external knowledge through collaboration, monitoring and mobility.

4.2. Collaborative knowledge sourcing

The first type of knowledge sourcing mechanism is collaboration, that is, interactive knowledge exchange between firms and other organisations. The firms were asked with whom they have collaborated and exchanged knowledge related to innovation during the last three years.

Table 4 provides an overview of the average number of collaboration partners identified by the interviewed firms.

The first significant finding relates to knowledge flows between the two identified groups of firms, namely content and technology providers. When it comes to collaborations with technology providers, significant differences between the two groups can be observed ($p = 0.017$). While the interviewed content providers list an average of 2.93 technology providers as contact partners, the corresponding number for the interviewed technology providers is 6.63. It is reasonable to argue that technology providers are valuable collaboration partners particularly for other technology providers, as they share similar knowledge bases. However, the result becomes striking when looking at collaboration with content providers. Following the same logic, one would expect content providers to connect primarily to other content providers. This is, however, not the case. Collaboration with content

Table 4. Average number of collaboration partners.

		Spatial dimension				
Interviewed firm	Contact partner	Regional	National	European	Global	SUM
Content provider *n* = 14	Content provider	4.64	1.07	0.21	0.29	6.21
Tech provider *n* = 8	Content provider	4.25	0.38	0.88	0.50	6.00
	P value =	0.8033	0.2052	0.2160	0.4187	0.9150
Content provider *n* = 14	Tech provider	2.43	0.07	0.21	0.21	2.93
Tech provider *n* = 8	Tech provider	4.38	1.13	0.38	0.75	6.63
	P value =	0.0873*	0.0096***	0.6479	0.2816	0.017**
Content provider *n* = 14	Other firms	1.00	0.07	0.07	–	1.14
Tech provider *n* = 8	Other firms	1.25	0.75	–	–	2.00
	P value =	0.5742	0.0286**	0.4632	–	0.1744
Content provider *n* = 14	Univ. and R&D's	1.14	0.14	0.07	–	1.36
Tech provider *n* = 8	Univ. and R&D's	3.00	0.25	0.13	–	3.38
	P value =	0.0063***	0.6410	0.6916	–	0.0047***
Content provider *n* = 14	Policy support org's	2.07	0.14	–	–	2.21
Tech provider *n* = 8	Policy support org's	2.00	–	–	–	2.00
	P value =	0.9261	–	–	–	0.7964
Content provider *n* = 14	Other Public org's	0.43	–	–	–	0.43
Tech provider *n* = 8	Other Public org's	–	0.13	–	–	0.13
	P value =	0.284	–	–	–	0.4569
Content provider *n* = 14	Total	11.71	1.50	0.57	0.50	14.29
Tech provider *n* = 8	Total	14.88	2.63	1.38	1.25	20.13
	P value =	0.3490	0.1819	0.2523	0.2827	0.1483

Notes:An unpaired *t*-test has been used to test the difference between the mean values of the two groups.
*Significant at a 10% level; **Significant at a 5% level; ***Significant at a 1% level.
Source: own data.

providers is equally important for both groups of firms ($p = 0.915$). Content providers are overall the most preferred collaboration partners, which points at the key role of symbolic knowledge for the media cluster.

Secondly, the table show that science- and technology-based knowledge enters the cluster mainly through technology providers. This becomes apparent as technology providers are significantly more active in collaborating with universities and other R&D organisations than content providers ($p = 0.0047$). Furthermore, the data show that the region is by far the most frequent geographical level for collaborations with universities and other R&D organisations. This can be explained by the fact that technology providers in the cluster have a strong focus on tailor-made solutions for the local market, and less on mass-production for global markets. Such tailor-made solutions demand close and continuous interaction, which is facilitated by geographical proximity.

A third finding is the importance of geographical proximity. Comparing the number of regional and non-regional collaboration partners reveals that close to 80% of all collaborations take place within in the Bergen region. This shows that the region is by far the most important arena for collaboration and knowledge exchange for firms in the cluster.

In addition to these statistically significant findings, also the absence of differences between content providers and technology providers is worth mentioning. Since prior studies have argued that symbolic knowledge is more localised than synthetic knowledge (e.g. Asheim, Boschma, and Cooke 2011; Martin and Moodysson 2013), one would expect to find geographical different preferences between the two groups of firms. However, no such differences can be observed. In fact, both groups of firms prioritise local knowledge sources over distant ones, irrespective of the type of knowledge base of the collaboration partner. The absence of geographical preferences between symbolic and synthetic firms can

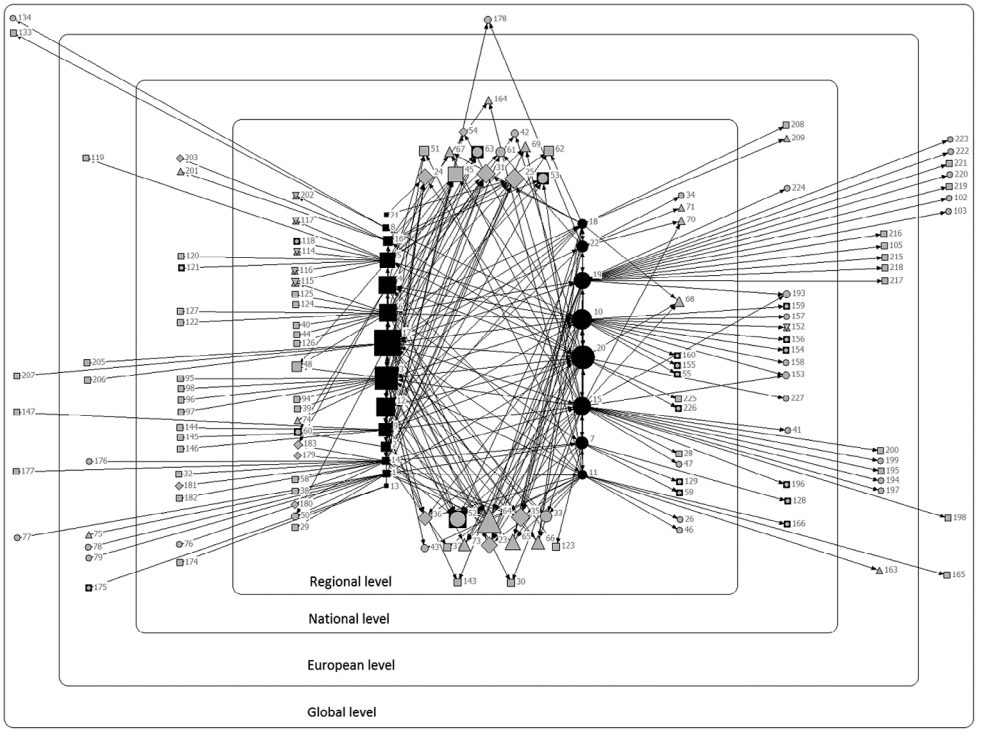

Figure 1. Collaboration network. Source: own draft.
Notes: The node shape reflects the type of organisation (square = content provider; circle = technology provider; circle-in-boxes = other types of firms; up-triangles = universities and R&D organisations; diamonds = policy support organisations; integrated triangles = other public organisations). The node colour displays whether the organisation has been interviewed (black = interviewed firm; grey = contact partners). The node size reflects its relative importance in the networks (in-degree centrality).

be explained by the fact that the media cluster in Bergen is dominated by two knowledge bases (in contrast to existing studies that argue that clusters have one critical knowledge base only, see, e.g. Tödtling, Asheim, and Boschma 2013). As the media cluster in Bergen relies on two different knowledge bases, geographical and institutional proximity are particularly important, as they can compensate for a low degree of cognitive proximity between partners (Mattes 2012; Hansen 2015; Menzel 2015).

Figure 1 illustrates the collaboration network. Among the interviewed firms, the most active collaborators are two content providers and two technology providers, namely the dominant local newspaper (ID 3), a national broadcasting company (ID 17), a locally based global technology provider (ID 20) and a local office of a national technology firm (ID 10). These firms connect similarly to content and technology providers, and, by virtue of their position in the network, are important knowledge hubs that link synthetic and symbolic knowledge. The most frequently mentioned collaboration partners are the local university (ID 64), followed by other local R&D organisations and policy support organisations.

When it comes to extra-regional collaboration, an online TV platform producer (ID 19), a firm specialised in interactive TV (ID 15) and a media tech company (ID 10) are the most outreaching technology providers. The most outreaching content providers are a video

Table 5. Average number of mobility sources.

		Spatial dimension				
Interviewed firm	Contact partner	Regional	National	European	Global	SUM
Content provider $n = 14$	Content provider	1.21	0.14	–	–	1.36
Tech provider $n = 8$	Content provider	1.25	0.25	–	–	1.50
	P value =	0.9419	0.5533	–	–	0.7990
Content provider $n = 14$	Tech provider	0.36	–	–	–	0.36
Tech provider $n = 8$	Tech provider	1.50	0.13	–	–	1.63
	P value =	0.0876*	–	–	–	0.0770*
Content provider $n = 14$	Univ. and R&D's	1.43	0.29	–	–	1.71
Tech provider $n = 8$	Univ. and R&D's	1.38	0.13	–	–	1.50
	P value =	0.9263	0.6870	–	–	0.7502
Content provider $n = 14$	Other types of firms	–	–	–	–	–
Tech provider $n = 8$	Other types of firms	0.50	–	0.13	–	0.63
	P value =	0.0202**	–	–	–	0.0171**
Content provider $n = 14$	Total	3.00	0.43	–	–	3.43
Tech provider $n = 8$	Total	4.63	0.50	0.13	–	5.25
	P value=	0.1657	0.8718	–	–	0.1629

Notes: An unpaired *t*-test has been used to test the difference between the mean values of the two groups.
*Significant at a 10% level; **Significant at a 5% level.
Source: own data.

game developer (ID 14) and a music company (ID 1). These companies are important as they provide the cluster with extra-regional knowledge.

4.3. Knowledge sourcing through mobility

The second knowledge-sourcing channel is mobility. By hiring skilled labour, firms gain access to tacit knowledge and can both upgrade or diversify their firm-internal knowledge base.

Table 5 displays labour mobility patterns. The firm representatives were asked from where and whom they hired during the last three years. When interpreting the results, recent developments in the media industry should be kept in mind. While the demand for media technology has been growing, traditional media content firms such as newspapers and publishing companies have been under efficiency pressures and have been outsourcing and downsizing (Currah 2009). Consequently, one can expect technology providers to be more active in hiring new employees than content providers.

In line with that, the table shows that the average number of mobility sources is higher for synthetic firms (5.25) than for symbolic firms (3.43). Furthermore, it displays an interesting unequal distribution of mobility sources. If the origin firm of a newly hired employee is a technology provider, the recruiting firm is also most likely a technology provider, and not a content provider ($p = 0.0876$). However, if the origin firm is a content provider, the difference is not significant. This is in line with the findings for the collaboration network, namely that Bergen media cluster favours symbolic knowledge over technological knowledge.

Finally, and addressing the geographical dimension, we find that the most important recruitment area is the Bergen region (88%), followed by other parts of Norway (11%), whereas international requirement is almost non-existent (1%). This confirms that the media industry is highly localised, in particular when it comes to hiring skilled labour (Alfken 2015; Alfken, Broekel, and Sternberg 2015). Thus, even more than for collaboration, geographical proximity is the key for knowledge sourcing through labour mobility. The success of media firms heavily depends on the access to a local pool of skilled labour.

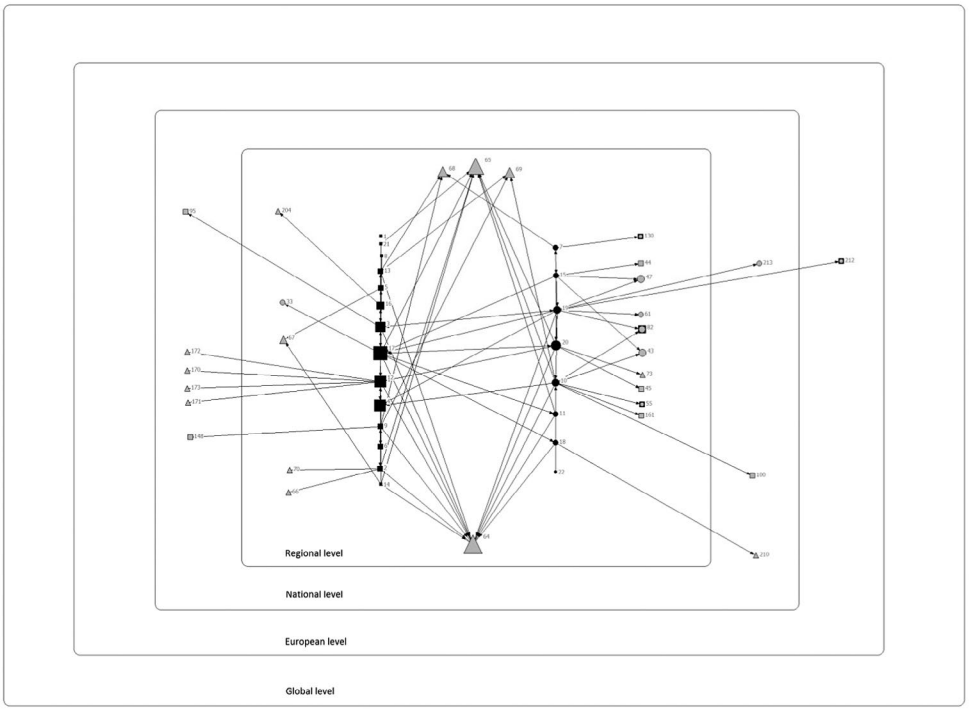

Figure 2. Mobility network. Source: own draft.
Notes: The node shape reflects the type of organisation (square = content provider; circle = technology provider; circle-in-boxes = other types of firms; up-triangles = universities and R&D organisations; diamonds = policy support organisations; integrated triangles = other public organisations). The node colour displays whether the organisation has been interviewed (black = interviewed firm; grey = contact partners). The node size reflects its relative importance in the networks (in-degree centrality).

Figure 2 visualises the mobility network. The second national broadcasters (ID 17) and a global technology provider (ID 20) stand out as the most frequently mentioned source of skilled labour. Together with the local newspaper (ID 3), they provide qualified labour to both symbolic and synthetic firms and constitute an important knowledge hub in the mobility network. Among all content providers, the first national broadcaster (ID 12) is most active in hiring extra-regionally, in particular from the national level, while the second national broadcaster (ID 17) hires mostly locally. Among the technology providers, the online TV platform producer (ID 19) is particular active in recruiting new employees and the only firm hiring from abroad. Among all actors, the local university (ID 64) is the most frequently mentioned source of skilled labour. This underlines the key importance of the local higher education system for the development of the cluster.

4.4. Knowledge sourcing through monitoring

The third knowledge sourcing mechanism is monitoring, that is, the observation of innovation activities of other organisations without engaging into direct interaction (Malmberg and Maskell 2002).

Table 6. Average number of monitoring sources.

		Spatial dimension				
Interviewed firm	Contact partner	Regional	National	European	Global	SUM
Content provider *n* = 14	Content provider	3.79	1.43	0.57	1.14	6.93
Tech provider *n* = 8	Content provider	6.88	0.38	0.88	0.38	8.50
	P value =	0.0500**	0.1219	0.6503	0.2935	0.4968
Content provider *n* = 14	Tech provider	2.07	0.07	0.14	0.50	2.79
Tech provider *n* = 8	Tech provider	4.63	1.13	0.13	0.75	6.63
	P value =	0.0488**	0.0011***	0.9120	0.7045	0.0091***
Content provider *n* = 14	Other types of firms	0.79	–	0.07	–	0.86
Tech provider *n* = 8	Other types of firms	1.38	–	–	0.25	1.63
	P value =	0.2593	–	–	–	0.2325
Content provider *n* = 14	Univ. and R&D's	1.64	–	–	–	1.64
Tech provider *n* = 8	Univ. and R&D's	2.00	0.25	–	–	2.25
	P value =	0.7037	–	–	–	0.5274
Content provider *n* = 14	Policy support org's	0.93	–	–	–	0.93
Tech provider *n* = 8	Policy support org's	1.75	–	–	–	1.75
	P value =	0.1962	–	–	–	0.1962
Content provider *n* = 14	Average total partners	9.21	1.50	0.79	1.64	13.14
Tech provider *n* = 8	Average total partners	16.63	1.75	1.00	1.38	20.75
	P value =	0.0507*	0.7326	0.7836	0.8259	0.0751*

Notes: An unpaired *t*-test has been used to test the difference between the mean values of the two groups.
*Significant at a 10% level; **Significant at a 5% level; ***Significant at a 1% level.
Source: own data.

Table 6 displays the average number of monitoring sources indicated by the firms. Based on the number of relations, monitoring can be seen as the most common knowledge-sourcing mechanism. The large majority of the monitoring activities occur within the boundaries of the region, which confirms the key role of local knowledge even for non-interactive knowledge sourcing. Compared to collaboration and mobility, however, the monitoring network is less bound to the region and more open towards international knowledge sources.

The observed patterns can be explained with the fact that monitoring is the least formalised and least costly means of knowledge acquisition. Without major social and economic costs, firms can monitor other organisations by attending trade fairs and exhibitions or by joining networking events. Furthermore, firms can use online platforms to screen other firms' innovation undertakings, which make it easy to monitor even over large geographical distance (Grabher and Ibert 2014; Aslesen and Sardo 2016).

Comparing content and technology providers, we find that both groups engage intensively in monitoring. However, technology providers maintain significantly (p = 0.0751) more monitoring relations (average 20.8, respectively, 13.1 relations). Similar to collaboration and mobility, technology providers monitor symbolic and synthetic firms to a similar degree (average 8.5, respectively, 6.6 relations), while content providers favour symbolic over synthetic firms (average 6.9, respectively, 2.8 relations). This once again supports the argument that symbolic knowledge is the most important knowledge type in the industry, and that the combination of knowledge bases occurs at an industry level involving firms specialising in different areas of expertise.

Figure 3 illustrates the monitoring network. As in the previous figures, the second national broadcaster (ID 17) and the global technology provider (ID 20) are the most central knowledge hubs. Holding positions as national market leaders, these two firms are monitored by more than half of the companies in the cluster. Even though they are the most monitored, they are relatively inward-oriented in their own monitoring activities and mention only few partners, most of which are located in the region. Other firms take

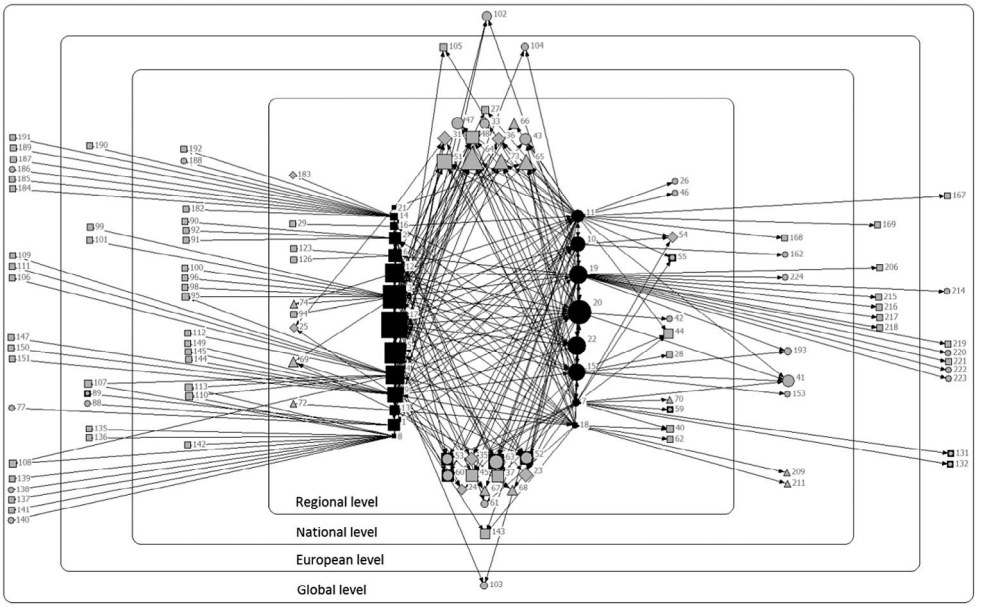

Figure 3. Monitoring network. Source: own draft.
Notes: The node shape reflects the type of organisation (square = content provider; circle = technology provider; circle-in-boxes = other types of firms; up-triangles = universities and R&D organisations; diamonds = policy support organisations; integrated triangles = other public organisations). The node colour displays whether the organisation has been interviewed (black = interviewed firm; grey = contact partners). The node size reflects its relative importance in the networks (in-degree centrality).

the position as main pipelines to national and international knowledge sources, notably the online TV platform producer (ID 19), a specialised news company (ID 8) and a video game developer (ID 14). This demonstrates that the most central firms in the cluster do not necessarily have the highest international outreach, while in contrast, firm that are less embedded in the core network can be important gatekeepers for accessing global knowledge (Morrison 2008). This can imply a potential danger to the cluster, when novel ideas from outside the region are filtered by gatekeepers and too few reach the core firms. A high degree of regional-mindedness has been found to hinder the innovativeness of firms and can potentially lead to regional lock-in and decline (Hassink 2010; Fitjar and Rodríguez-Pose 2011).

5. Discussion and conclusion

This paper contributes to the literature by shedding light on the geography of knowledge sourcing in a cluster that draws on two knowledge bases. We find that symbolic knowledge plays a critical role in the media industry, as it is typical for creative and cultural industries. However, innovation is not only about the generation of media content based on symbolic knowledge, but also about the application and development of media technologies, for which synthetic knowledge is crucial. In view of that, the study shows that media firms often specialise in either symbolic or synthetic knowledge and combine both knowledge bases in the innovation process.

Drawing on this finding, the paper analyses how and from where firms acquire and combine different knowledge. The Bergen region is the prime arena in which knowledge is sourced and combined, even though knowledge exchange also takes place across regional boundaries. In line with previous studies on the role of the local knowledge for creative and cultural industries (Lazzeretti, Boix, and Capone 2008; Martin and Moodysson 2011; Plum and Hassink 2014), we find intense knowledge exchange in the local milieu. However, we find no difference in geographical knowledge sourcing preferences between symbolic and synthetic knowledge-based firms as one would expect from prior research (Martin and Moodysson 2011). Knowledge sourcing from universities and other R&D organisations is especially done by technology providers. Thus, technology providers play an important role for the cluster also as they create an access to science-based knowledge (Robertson and Smith 2008).

Contributing to this argument, our study provides a novel and more differentiated perspective on how firms source and combine knowledge from different scales, namely through collaboration, monitoring and mobility. Interestingly, we find that local knowledge sourcing often takes place between firms with different knowledge bases (i.e. content and technology providers). Those firms innovate on different rationales and use different innovation practices, but engage into intensive knowledge exchange with one another. A shared local environment can compensate for a lack of cognitive proximity and enable knowledge exchange even between very different actors. Consequently, the region can be seen as key arena for firms to both strengthen their core competences by exchanging knowledge with cognitively similar organisations, and to diversify and go beyond existing competences by collaborating, monitoring and recruiting from organisations with dissimilar knowledge base.

Furthermore, we find that the geography of knowledge sourcing differs considerably between knowledge channels. Monitoring is least bound to spatial proximity. Firms observe other organisations on the national and international level without engaging into direct interaction. They use internet platforms or specialised magazines to observe their competitors (Grabher and Ibert 2014) and attend international conferences and trade fairs, which has been stressed by the interview partners. By that means, they take advantage of temporary forms of proximity, which make physical co-location less vital (Bathelt and Gibson 2013). Collaboration takes place mostly locally, irrespective of the type of firms involved, which confirms the key role of proximity for interactive learning and the importance of local knowledge for symbolic innovation (Asheim, Boschma, and Cooke 2011). The third channel, labour mobility, appears to be even more localised. Among the interviewed firms, only one has hired internationally, while the majority recruits locally. Even in creative and cultural industries such as media, skilled workforce tends to stay in its home region and is reluctant to inter-regional job migration (Alfken, Broekel, and Sternberg 2015). This shows that the local labour market is a key asset of the development of the cluster.

The paper calls for further research on the geography of innovation networks and combinatorial knowledge dynamics. The empirical analysis dealt with media firms located in a thick and diversified region, which raises the question to what extend the results can be generalised to other regional or industrial settings. It is reasonable to expect that firm of any industry located in peripheral regions have fewer knowledge sources available locally, and consequently a stronger need to reach out nationally and internationally. But then again, one can also expect that they have difficulties to collaborate externally and hire staff from outside the region, due to lower accessibility and a lack of urban amenities. Furthermore,

the question raises whether the results are specific to the media industry, or whether firms in other industries have similar ways to acquire and combine knowledge. It is, for instance, reasonable to expect that firms in science-based industries have a strong tendency to source knowledge globally, due to the codifiability and universal applicability of analytical knowledge. Whether the results hold for other types of RIS and other types of industries are questions for future research.

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