GOTHENBURG STUDIES IN INNOVATION AND ENTREPRENEURSHIP 3

# Industry Dynamics and Relatedness of Knowledge

## Knowledge Transfer through Labor Mobility and Entrepreneurship in the West Swedish Textile Industry

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ISBN print: 978-91-7833-045-4
ISBN digital: 978-91-7833-046-1
Link: http://hdl.handle.net/2077/56139
Printed by BrandFactory
Gothenburg, Sweden. 2018

## Abstract

This PhD thesis investigates how industry dynamics are influenced by knowledge transferred through labor mobility and entrepreneurship by focusing on the role of relatedness of the knowledge. The empirical setting is the textile industry in the West Swedish region Västra Götaland, which encompasses the sub-industries Manufacturing of textiles and Wholesale and retail trade of textiles. For the purpose of the thesis, quantitative methods are applied, where linked employee–employer data in Sweden are used for the period 1990–2014.

The thesis finds that co-location alone does not explain the patterns of knowledge transfer through labor mobility in the textile industry—instead, the relatedness of knowledge (reflecting cognitive proximity) is also influential. The influence of relatedness of knowledge is also shown for the productivity of the knowledge that is sourced as well as for entrepreneurial performance. To study productive knowledge sourcing, the influence of the workers' industry experience is investigated, whereas to study entrepreneurial performance, the way the entrepreneur's industry experience influences the survival chances of the venture is investigated. Both studies find that the role of relatedness of the knowledge, as indicated by individuals' industry experience, differs between Manufacturing of textiles and Wholesale and retail trade of textiles. Knowledge from related industries is comparatively more important in the former than in the latter, whereas knowledge that originates from the same sub-industry is especially beneficial in the latter. An important additional aspect is that the relative usefulness of knowledge from related industries differs somewhat between the studies.

The analysis discusses these observed differences between Manufacturing of textiles and Wholesale and retail trade of textiles by relating them to different knowledge requirements that are likely to be prevalent in the different industry life-cycle phases the two sub-industries of the textile industry were subject to. The thesis proposes that future research should take industry life-cycle phases into account as well as distinguish between different sources of knowledge, firms, and outcomes when investigating the role of relatedness of knowledge for development of firms, industries, and the economy at large.

**Keywords:** Relatedness, knowledge transfer, industry dynamics, labor mobility, entrepreneurship, cognitive proximity, industry life-cycle phases

**Abstract in Swedish**

Denna doktorsavhandling undersöker hur industridynamik påverkas av kunskap som överförs genom jobb-byten och entreprenörskap, med fokus på rollen av kunskapens grad av närhet, kallad kunskapsnärhet. Den empiriska kontexten är textilindustrin i den västsvenska regionen Västra Götaland, vilken innefattar branscherna Textiltillverkning och Textilhandel. Genom kvantitativa metoder analyseras i avhandlingens syfte individ-data som länkar arbetstagare och arbetsgivare i Sverige under perioden 1990–2014.

Avhandlingen finner att inte enbart samlokalisering kan förklara mönstren bakom kunskapsöverföring genom jobb-byten i textilindustrin—istället så är även graden av kunskapsnärhet (som reflekterar kognitiv närhet) betydande. Betydelsen av graden av kunskapsnärhet påvisas även för produktiviteten av kunskapen som eftersöks (kunskapsanskaffning) samt för entreprenöriell framgång. För att studera produktiv kunskapsanskaffning undersöks betydelsen av arbetarnas industrierfarenhet, medan för att studera entreprenöriell framgång undersöks hur entreprenörens industrierfarenhet påverkar dess nystartade företags chans till överlevnad. Båda studierna finner att graden av kunskapsnärhet, i termer av individernas industrierfarenhet, skiljer sig åt mellan Textiltillverkning och Textilhandel. Kunskap från relaterade industrier är jämförelsevis viktigare i Textiltillverkning än i Textilhandel, medan kunskap från samma textilbransch är särskilt gynnsam i Textilhandel. Ytterligare en viktig aspekt är att den relativa nyttan av kunskap från relaterade industrier skiljer sig något åt mellan de båda studierna.

I analysen diskuteras de observerade skillnaderna mellan Textiltillverkning och Textilhandel genom att relatera dem till olika kunskapsbehov som är sannolikt förekommande i de olika industri-livscykelfaserna som dessa branscher tillhört. Avhandlingen föreslår att framtida forskning bör ta industri-livscykelfaser i beaktande samt särskilja såväl olika källor till kunskap som olika företag och olika utfall i undersökningar av betydelsen av graden av kunskapsnärhet för utveckling av företag, industrier och ekonomin i sin helhet.

## Appended Papers

### Paper I

Geographical and cognitive labor mobility patterns: A comparative analysis of two parts of the West Swedish textile industry. Author: Snöfrid B. Herou. 2018. An earlier version was presented at the Druid Academy 2017 conference, Odense, Denmark, 18-20 January, 2017.

### Paper II

Knowledge sourcing in the West Swedish textile industry: The role of labor from related industries. Author: Snöfrid B. Herou. 2018.

### Paper III

The influence of the entrepreneur's prior industry experience on the venture's survival: A comparative analysis on the role of relatedness in two parts of the West Swedish textile industry. Author: Snöfrid B. Herou. 2018. An earlier version was presented at the Druid Academy 2018 conference, Odense, Denmark, 17-19 January, 2018.

**Acknowledgments**

Writing this PhD thesis has been a stimulating and challenging journey of learning and exploration of research in an exciting field of societal interest. Although I am the only author of the papers in this thesis, I have greatly benefited from discussions with and comments by others, whom I would like to acknowledge.

First, I would like to thank my supervisor Maureen McKelvey for encouraging and challenging me along the PhD process. When I have been too focused on details she has asked me the right questions about what my research means at a higher level and why it is interesting. Those questions are doubtless important and have definitely pushed me forward to better explicate the contribution and interest of my research. I am sincerely grateful for her comments and her engagement in our discussions.

I also want to acknowledge my supervisor Daniel Ljungberg, who has been an important support throughout the whole PhD process. He has made himself available on a daily basis for small and large questions with comments and advice that have greatly facilitated my time as a PhD student. He also taught me the foundations of how to program in STATA—the statistical software program that I have used for processing and analyzing the data for all the research in this thesis—and helped me to solve issues along the way. He has made possible the programming skills I have today and inspired me to find smart and time-efficient solutions when programming for using this large-scale database. I am truly thankful for his kindness.

Guido Buenstorf stepped in as a third supervisor later in the process, but has nevertheless given me plentiful thoughtful comments on my research. His challenging questions, engagement in discussions, and encouragements have been of great value to me.

I have been blessed with having additional friendly colleagues around me. I dearly appreciate the encouragements from and engagement in discussions by my PhD student colleagues Erik Gustafsson, Karin Berg, Linus Brunnström, and Daniel Hemberg at the Institute of Innovation and Entrepreneurship. Many thanks also to my senior colleagues at the institute who have made themselves available for discussions and thoughtful advice: Ethan Gifford, Evangelos Bourelos, Johan Brink, Sven Lindmark, Staffan Albinsson, Olof Zaring, Rick Middel, Ryan Rumble, and Rugnvaldur Saemundsson, and to my former colleagues Anders Nilsson and Ali Mohammadi.

I have also benefited from useful discussions and interaction with guest researchers and others associated with the institute: Ida Hermansson, Solmaz Sadjadi Rad, Magnus Holmén, Marcus Holgersson, Astrid Heidemann Lassen, Elena Mas Tur, Charlie Karlsson, Andreas Trädgårdh, Josefine Berggren, Sebastian Misurak, Hanne Peeters, and Sharmista Bagchi-Sen, Jun Jin among others. Thanks also to Marin Henning and Erik Elldér for help with accessing the database and to the administrators at the Department of Economy and Society for outstanding support.

My research has benefited greatly from comments by discussants at my PhD seminars: Martin Andersson at my final seminar, Martin Henning at my halfway seminar, and Rani Dang at my planning seminar when I presented my initial research ideas. I am also grateful for the comments and advice I received from participants at the "Workshop on Industry Relatedness and Regional Change" in Umeå 2014, the "Third International Workshop on Inter-industry Relatedness" in Gothenburg 2015, and the Druid Academy conferences in Odense 2017 and 2018. A special thanks to Jacob Rubæk Holm for useful comments and kind advice at the Druid Academy 2017 (see also my note in Paper III) and to his colleague Christian Richter Østergaard for valuable comments at the workshops and conferences mentioned.

Last but not least, thanks to my family, friends, and relatives who have been a great support to me throughout my PhD studies. A special thanks to my closest family: my father, who has not only encouraged me but also been a great mentor to me throughout these years, which has been invaluable to me; to my mother, for encouragement and for being genuinely interested in my research; and to my brother, sister, and grandparents for warm support.

Snöfrid Börjesson Herou
April, 2018

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# 1 Introduction

The aim of this PhD thesis is to contribute to the understanding of how industry dynamics are influenced by knowledge transferred through labor mobility and entrepreneurship by focusing on the role of relatedness of knowledge. The empirical setting is the textile industry in the West Swedish region Västra Götaland (VG). I have chosen to study this industry due to the different dynamics present in the industry including both a renewal phase and a maturity phase, as exemplified in its two sub-industries.

Industry dynamics is an important topic for research since it contributes to the understanding of how to facilitate development and renewal of industries. During the past hundreds of years, the world has been subject to tremendous development. Industries have been formed for the sake of producing goods and services for the improvement of our well-being and humans have become wealthier and healthier as a result of technological advances related to transport, food production, health, information and communication, buildings, and so on. Whereas technological development has significantly improved the lives of most humans, it has also come with an undeniable cost for other animals, nature, and climate. A large part of the human population also still suffers from poverty, diseases, and hunger. We therefore stand in front of large challenges connected to sustainability, ethics, and health. However, with improved technological development focused on resolving such issues, there is hope for a brighter future. With this in view, sustainable technological development is high on the policy agendas around the world. This is not least apparent in the 2030 Agenda for Sustainable Development by the United Nations (2015), where sustainable technological development is put forth as a key for reaching many of the goals. This development, in addition, has to go hand in hand with and benefit from the powerful development of digitalization and artificial intelligence, which also will transform industries and their need for knowledge. The challenges will, based upon the present situation, oblige many industries to depart from old paths and renew themselves. To facilitate for this development, more research on mechanisms behind industry dynamics is needed, including on the renewal and maturity of traditional industries.

This thesis examines knowledge transfer in renewal and maturity in one specific traditional industry, the textile industry, which historically has been one of the dominating industries in Sweden (Cele, 2007)—not least in VG (Sandberg and Waara, 2014). The industry has, however, since the 1950s declined in Sweden by about 90%-95% in terms of number of employees. In the 1950s the manufacturing in this industry concerned clothing, other sewn products, and more upstream products (yarns, fabrics, tricot, etc.) and was highly labor intensive (Gråbacke and Jörnmark, 2008). Today, the textile industry in Sweden is characterized by interdisciplinary innovations, manufacture of knowledge-intensive technical textiles, and the headquarters of clothing companies, in addition to retail trade. What caused this industry transformation was essentially external change, which led to internal transformation of the industry. The external change that forced the industry to transform was the increased internationalization of the industry and competition from low-wage countries. As the actors in the Swedish textile industry could not compete with the prices offered by international actors due to the higher wage level in Sweden, they had to re-focus their efforts. Similar to evolutionary theories, my perspective is that this meant that those best suited to adapt to the changing environment managed to stay in business.

As recognized in the management literature, those firms that do not adapt to and survive discontinuities typically are victims of their prior success (Christensen, 1997), where yesterday's core capabilities become core rigidities (Leonard-Barton, 1992). Central to the adaptation of firms is the need, therefore, to refocus and do things differently. This necessitates learning (Leonard-Barton, 1992), which is facilitated by internalizing new knowledge external to the firm (Song et al., 2003). Similar ideas are used in this thesis to understand industry dynamics.

However, how do industries survive, grow, and renew? What types of knowledge are fundamental for economic development? Such questions have been debated over the years in a range of different fields drawn upon in this thesis. I combine the fields in relation to my topic on the role of relatedness of knowledge for industry dynamics, which enables me to address the aims of my thesis. I have chosen to focus upon a subset of theories primarily from the fields of innovation, entrepreneurship, evolutionary economics, and evolutionary economic geography, since they share common elements connected to Schumpeterian-inspired theories. These regard the importance of how new combinations (here interpreted in terms of knowledge) influence innovation and entrepreneurship, as well as more broadly economic growth and creative destruction.

Lately, evolutionary economic geographers have increasingly made use of theories on relatedness of knowledge and cognitive proximity to study the evolution of

economic activities in a geographical context.[1] This partly builds upon a debate that has centered on the types of knowledge present in industry agglomerations that are most likely to result in growth through knowledge spillovers from interactions between different actors. On the one hand, it has been argued that the specialization found in agglomerations of a few dominating industries is the most advantageous setting for economic growth. This is because actors in such settings benefit from interacting with each other since, due to similar knowledge (and cognitive structures), they can more effortlessly communicate and exchange knowledge (in addition to benefiting from labor-market pooling and larger infrastructures of specialized suppliers) (Beaudry and Schiffauerova, 2009). However, it has also been argued that diversity is likely to foster growth (Beaudry and Schiffauerova, 2009; de Groot et al., 2016; Feldman, 1999; Jacobs, 1969). In line with Schumpeter's (1934) recognition of the importance of new combinations of knowledge for economic development, it is suggested that application of knowledge from a diverse set of industries provides more opportunities for innovation (Beaudry and Schiffauerova, 2009; de Groot et al., 2016; Feldman, 1999). Although extensively researched, there are contradictory results about the relative importance of specialization and diversification in driving growth of regions (Beaudry and Schiffauerova, 2009; de Groot et al., 2016).

In recent years, evolutionary economic geographers have incorporated new theories from the innovation literature on the mechanisms behind the transfer and creation of knowledge that are likely to result in innovation through new combinations. Since cognitive distance has been recognized to come with a tradeoff between novelty and understandability, it has been increasingly acknowledged that knowledge is created and transferred most beneficially between agents when the cognitive distance between them is neither too large nor too small (Nooteboom, 2000), or in other words, when the agents have related knowledge bases. Evolutionary economic geographers have therefore come to emphasize the role of *related* knowledge exchange for the development of industries. Similarly, at a macro level, evolutionary economic geographers propose that in regions and countries, neither industry settings that are too specialized nor those that are too diversified can be accredited for growth; instead, settings hosting a variety of

[1] More specifically, evolutionary economic geography is concerned with investigating asymmetric geographical distribution of economic development by drawing upon theories and concepts in evolutionary economics (Boschma and Martin, 2007)

related industries, labeled as *related variety*, are argued to provide the best condition (Frenken et al., 2007). Empirical evidence points in a general direction towards a positive effect of a related variety of industries for economic development. There are, however, some mixed results in this regard, which partly indicates that the issue is more complex than initially suggested.

Whereas much work this far has been done at the macro level, I claim that more clarity in the question of how relatedness of knowledge influences industry dynamics can be gained by thoroughly investigating the role of relatedness of knowledge at the micro-level for the mechanisms behind industry development (see also Content and Frenken, 2016 and Boschma, 2017). In addition, I propose that there are reasons to believe that the role of related knowledge varies throughout the industry life cycle due to different knowledge requirements in the different phases of the industry life cycle. This partly builds upon previous research (Neffke et al., 2011b).

The process Schumpeter (1942) called "creative destruction"—which in the context of this PhD thesis can be seen as the structures of old knowledge being destroyed and replaced by structures created by new combinations of knowledge—is in this thesis regarded to be apparent in industries in renewal. I therefore propose that industries in renewal are likely to benefit more from related knowledge than from industry-specific knowledge, as compared to industries in the maturity phase. There is a scarcity of research that takes into account such differences in the role of relatedness connected to different industry life-cycle phases, especially with regard to renewal. The aim of this thesis is to contribute to the research field more insight about how the role of relatedness of knowledge might differ in different phases of the industry life cycle. More specifically, the thesis provides a comparative analysis of Manufacturing of textiles and Wholesale and retail trade of textiles in VG, which adhered to renewal and maturity, respectively, during the period of study.

To understand the mechanisms behind industry dynamics, I argue that it is necessary to study the knowledge transfer activities of firms. Labor mobility is put forth in the literature as an essential mechanism (or channel) through which new knowledge can enter the firm and stimulate the learning and development (A. Malmberg and Power, 2005; Power and Lundmark, 2004; Song et al., 2003) that enables the firm to respond to its environment  Therefore, I have chosen to explicitly focus on knowledge transfer through the mobility of individuals, in the form of either workers or the entrepreneurs themselves.

My objective in writing this thesis has been to address the following three questions:

1) *How are the labor mobility patterns of the two parts of the textile industry in VG described in geographical and cognitive dimensions?*

2) *How is productive knowledge sourcing influenced by the relatedness of the knowledge that is sourced through labor mobility in the two parts of the textile industry in VG?*

3) *How does the relatedness of the entrepreneur's prior industry experience influence the venture's survival in the two parts of the textile industry in VG?*

For each of these objectives, the results for Manufacturing of textiles and Wholesale and retail trade of textiles in VG are compared and analyzed in relation to the industry life-cycle phases they adhere to.

This PhD thesis is written within the field of innovation, entrepreneurship, and management of intellectual assets, and specifically in relation to the topic of innovation processes, knowledge and learning, and entrepreneurship. More generally, my thesis has two main contributions: (1) It presents micro level studies, that investigate industry labor mobility patterns. My contribution is to more directly link relatedness of knowledge to mechanisms of labor mobility and entrepreneurship, which foster industry development. (2) The thesis, moreover, contributes an industry life-cycle perspective to understand how relatedness of knowledge influences industry dynamics. This has previously received little quantitative empirical investigation. My perspective for differentiating two sub-industries in the textile industry is built on theories about how and why knowledge requirements are likely to differ in different industry life-cycle phases.

The rest of the thesis is structured as follows. Section 2 provides an overview of the theoretical framework of this thesis. As such, this section reviews prior literature and research in the field. It especially concerns literature in innovation, entrepreneurship, and evolutionary economic geography with focus on knowledge exchange, proximities, agglomeration externalities, and industry life cycles. Section 3 provides a background of the textile industry in VG. Its purpose is to contextualize the empirical setting; as such, this section describes the history of the textile industry in VG and the structural change that has taken place during the 20$^{th}$ century until 2010. Section 4 describes the data and method that have been used in the three empirical studies. This section focuses on issues connected to sampling, data preparation, construction of key variables, and research design.

Particular attention is given to the empirical measurement of "relatedness of knowledge", which is used in all three empirical studies in this thesis. I therefore describe this concept in terms of how it is operationalized and measured in previous studies. I also explain the rationale behind using skill-relatedness and describe how it has been measured in this thesis. Section 5 briefly summarizes the papers, to give an overview of the research. Section 6 provides a concluding discussion, including the main findings, limitations and suggestions for future research.

Last, but not least, the three papers constituting the research are found appended at the end of this thesis. In addition to presenting results, discussion, and conclusions of the research conducted for this thesis, these papers provide a detailed account of the respective topics in terms of theoretical framework and description of methods and data.

# 2 Theoretical framework

Since the purpose of my PhD thesis is to investigate the role of relatedness of knowledge for industry dynamics, focusing on knowledge transfer mechanisms through labor mobility and entrepreneurship, the theoretical framework presented in this section aims to provide a guide to the literature on this topic. This section begins, in Section 2.1, with acknowledging that innovation, entrepreneurship, and intellectual assets function as the driving forces behind industry and economic development. I explain that the combining of knowledge is central in this regard and that knowledge transfer that brings in new knowledge stimulates this process. Section 2.2 is concerned with the type of knowledge—in connection to relatedness—that is most fruitful for the development of firms, industries, and the economy at large. Thereafter, labor mobility is described in Section 2.3 as an important knowledge transfer mechanism through which new knowledge enters industries. This is why I have chosen in this thesis to focus on labor mobility of workers and entrepreneurs in studying the role of relatedness of knowledge for industry development. However, in Section 2.4, I also describe that the role of relatedness of knowledge is likely to vary throughout the industry life cycle and present expectations in this regard. The literature in this theoretical framework mainly draws upon theories from innovation, entrepreneurship, evolutionary economics, and evolutionary economic geography, the fields that this thesis aims to contribute to.

## 2.1 The role of knowledge in the economy

### 2.1.1 Economic development as influenced by knowledge, innovation, and entrepreneurship

The role of knowledge for growth has long been a prime concern in social sciences. During the past decades the understanding in this matter has improved significantly as important insights have arisen about how the economic system evolves in response to the stimuli of technological development, industry dynamics, and firm heterogeneity (Henning and McKelvey, 2018). In opposition to the neoclassical view of the economy as an equilibrium system, Schumpeter

introduced in 1934[2] his ground-breaking theory of innovation as central in driving economic development, which laid the foundation for subsequent theorizing about the evolution of economic activities (Nelson and Winter, 1982). In light of the notion of innovation as arising from new combinations Schumpeter (1934) posited that innovation introduces change and fuels development. Development, he stated, is "defined by the carrying out of new combinations" (Schumpeter, 1934, p. 66). These new combinations are described as being introduced by entrepreneurs; as Schumpeter (1934, p. 75) put it, "[I]t is the carrying out of new combinations that defines the entrepreneur". In a later contribution he stated "The fundamental impulse that sets and keeps the capitalist engine in motion comes from the new consumers' goods, the new methods of production or transportation, the new markets, the new forms of industrial organization that capitalist enterprise creates". This is the source to what he famously wrote "revolutionizes the economic structure *from within*, incessantly destroying the old one, incessantly creating a new one"—a process he coined *creative destruction* and highlighted as the "essential fact about capitalism" (p.83). The notion of economic development as a result of creative destruction fueled by new combinations has thereafter been widely adopted in fields such as innovation, entrepreneurship, evolutionary economics, and evolutionary economic geography. In relation to this thesis, I interpret innovation to originate from[3] knowledge recombination, in line with Miller, Fern, and Cardinal (2007). Here, knowledge refers to both tacit and explicit knowledge, where the former involves *know-how* in terms of practical skills, and the latter implies "*knowing about* facts and theories" (Grant, 1996, p. 111).

Whereas Schumpeter first saw the entrepreneur as the primary agent behind innovation, he later came to emphasize the role of the incumbent firms for innovation. In this thesis I have chosen to study both aspects. I acknowledge incumbents as important agents that advance economic development by introducing innovations through carrying out new combinations of knowledge (Miller et al., 2007). Also in line with Schumpeter's first vision, I see entrepreneurs as innovators and important change agents who "challenge incumbent[s] through creative destruction" (Malerba and McKelvey, 2018, p. 6).[4]

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[2] In 1934 in English and in 1911 in German.

[3] Although this thesis specifically focuses on the origins of innovation in terms of new combinations, it shall be noted that for new combinations to result in innovation, technological and commercial success are required.

[4] An entrepreneur is in this thesis an individual who creates a new firm (see for example Gartner, 1988).

The ever-changing environment characterized by creative destruction implies that firms constantly have to adapt in order to successfully compete and survive (Nelson and Winter, 1982). As knowledge is the foundation of competitive advantage (Leonard-Barton, 1992; Murmann, 2003), adaptation in this ever-changing environment means that firms need to engage in learning (Nelson and Winter, 1982), where the acquisition of new knowledge is an important element (Cohen and Levinthal, 1990; Song et al., 2003).

Therefore, from this literature, I recognize the importance of focusing both on incumbent firms and entrepreneurial firms in studying industry dynamics and renewal. Moreover, while I do not study innovations per se, I make the assumption that innovations are based upon new combinations of knowledge. In the following sub-section (2.1.2), the acquisition of new knowledge is explained as largely depending on prior knowledge.

### 2.1.2 Prior knowledge

The importance of prior knowledge is in this sub-section described first in relation to incumbent firms and thereafter in relation to entrepreneurs. Understanding the role of prior knowledge of the firm and entrepreneur depends upon a conceptualization of theories of the firm, as related to resources and capabilities, which is outlined below.

The role of prior knowledge was emphasized by Penrose already in 1959 in "The theory of the growth of the firm", in which she introduced the *resource-based perspective* on the firm. With this perspective, she contributed by unfolding the '"black box" of the firm, which until then had not been given much attention in economics. By shedding light on the growth of the firm, she also contributed to the endogenous perspective on the economy that Schumpeter and among others, had advocated. Central in Penrose's reasoning is that a firm can only grow as fast as its knowledge. Penrose recognized that employees' existent knowledge about the firm's resources as well as unused knowledge "shape the scope and direction of the search for knowledge" (Penrose, 1959, p. 77) and "determine the response of the firm in the external world" (Penrose, 1959, p. 80). Thus, Penrose emphasized the importance of prior knowledge for being able to recognize valuable resources, knowledge, and ideas in the environment and argued that learning emanates from established resources (Cantwell, 2001).

In later developments of theories of the firm in this tradition, the firm's ability to create new knowledge, to learn, and to innovate has been acknowledged as depending on its capability "to recognize the value of new, external information,

assimilate it, and apply it to commercial ends" (Cohen and Levinthal, 1990, p. 128). Cohen and Levinthal (1990) called this *absorptive capacity*. From a resource-based perspective, knowledge of firms resides within individuals, and is said to be the most important resource of the firm (Grant, 1996). Likewise, Cohen and Levinthal (1990) and Simon (1991) noticed that organizations learn through their members. Consequently, the firm's capacity to absorb new knowledge depends to a large extent on its employees' absorptive capacities, which in turn depend on individual *prior related knowledge*. Whereas the role of *related* knowledge will be described in greater detail in the following sections, it shall be noted that prior knowledge needs to be *related* (or similar) for the human cognition be able to assimilate and make use of new knowledge (Cohen and Levinthal, 1990). Similarly to the ideas behind absorptive capacity Kogut and Zander (1992, p. 384) used the term *combinative capabilities* to describe the capabilities that humans use "to synthesize and apply current and acquired knowledge". This highlights the fact that knowledge creation and application is a result of the combination of new and pre-existing knowledge.

In the entrepreneurship field, the role of prior knowledge has been studied in terms of opportunity recognition and performance of entrepreneurial ventures. It has, for example, been acknowledged that entrepreneurs discover opportunities that are related to their prior knowledge (Shane, 2000). Helfat and Lieberman (2002) also pointed to the importance of prior knowledge when arguing that successful market entry depends on the *pre-history* of the entrepreneur. Similarly, it has been recognized that spinoffs benefit from the prior knowledge the entrepreneurs have acquired at the parent firm (Klepper, 2016; 2002).

The influence of the entrepreneur's prior knowledge on the venture's performance acts both directly and indirectly. It acts directly through actions based upon the knowledge and capabilities present in the venture. The indirect influence (Dencker et al., 2009) of the entrepreneur's prior knowledge acts through subsequent learning activities in terms of path-dependent[5] processes where prior knowledge influences what type of knowledge is likely to be absorbed in the future (Cohen and Levinthal, 1990; Dencker et al., 2009). This is why a matching between the entrepreneur's knowledge and the required knowledge in an industry is argued to positively influence the survival chances of the venture (Helfat and Lieberman,

[5] Martin and Sunley (2006, p. 399) define a path-dependent process or system as "one whose outcome evolves as a consequence of the process's or system's own history".

2002). These theories have found vast support in research, where it has been found that industry-specific knowledge positively affects survival (M. Andersson and Klepper, 2013; Arribas and Vila, 2007; Brüderl et al., 1992; Dencker et al., 2009; T. Eriksson and Moritz Kuhn, 2006; Fontana and Nesta, 2010; Gimeno et al., 1997; Klepper, 2002), sales (see, for example, Delmar and Shane 2006), and entrepreneurial earnings (for example, Frederiksen et al. 2016) of start-ups.

In summary, from this literature, I have extracted that prior knowledge is largely important to firms. This is because the firm's success in accessing and making use of new knowledge to a large extent depends on its prior knowledge, held by its employees or by the entrepreneur.

## 2.2 The role of cognitive and geographical proximity for knowledge exchange

This section builds upon the insight above that economic development relies upon new combinations (Schumpeter, 1942; 1934) of knowledge. However, the realization of innovations through the combination of different knowledge inputs is recognized to seldom be pursued by sole individuals acting on their own, but rather is recognized as a highly interactive undertaking involving knowledge exchange between different types of actors (Håkansson, 1989). Therefore, the following sub-sections are concerned with different forms of proximities between actors that facilitate the coordination of knowledge exchange with an emphasis on cognitive proximity (Boschma, 2005).

### 2.2.1 Cognitive and geographical proximity

Similar to the importance of prior knowledge for recognizing, assimilating, and making use of new knowledge, discussed in the previous section, knowledge exchange between actors is facilitated if they are cognitively proximate to each other (Boschma, 2005). Cognitive proximity can be defined as "the similarities in the way actors perceive, interpret, understand and evaluate the world" (Wuyts et al., 2005, cited in Knoben and Oerlemans, 2006, p. 77), which here is largely based upon the knowledge of the actors (Cohen and Levinthal, 1990).

In economic geography more widely, the role of cognitive proximity in knowledge exchange and learning has traditionally been somewhat overshadowed by geographical proximity: Knowledge exchange has often been regarded as arising just from mere co-location of economic activity in spatial agglomerations. The

increased information and knowledge exchanges that tend to be present in those spatial agglomerations of economic activity have been described in terms of "buzz" or "localized knowledge spillovers" (Bathelt et al., 2004; Breschi and Lissoni, 2001a; Storper and Venables, 2004). In search of such knowledge spillovers, many studies have used patent data to capture and measure their existence (Breschi and Lissoni, 2001a). A positive relationship has, for example, been found between universities' R&D performance (research spending) and the number of corporate patents in U.S. states, from which it was indicated that knowledge spills over from universities to firms (Jaffe, 1989). Others have also found that innovation tends to cluster in close geographical proximity to knowledge sources such as industry R&D, university research, and skilled labor (see for example Audretsch and Feldman, 1996). In an article that thoroughly reviews some of the work done on localized knowledge spillovers and their effect on innovation, Breschi and Lissoni (2001a) raised important criticism of many of the studies in the area. The authors argued that an association between, for example, university research expenditure and firm patenting is of an indirect kind, as it tends to focus on input–output models rather than processes, and the reasons behind the association are unsatisfyingly explained.

Critics of the aforementioned studies on the role of geographical proximity suggest that other forms of proximities found in social relationships, networks, and epistemic communities most likely condition a large part of the associations (Breschi and Lissoni, 2001b). When studying the influence of geographical proximity in the economy, it is therefore important to find a way to "isolate it from the other proximities" (Boschma, 2005, p. 69). Beyond geographical proximity, the other forms of proximities, in addition to cognitive proximity, that the author proposed as likely to influence knowledge exchange are social, institutional, and organizational proximities, as these also "reduce uncertainty and solve the problem of coordination" (p.62). These proximities function as substitutes for geographical proximity (Boschma, 2005). Cognitive proximity is, however, regarded as a requirement for knowledge exchange, since this form of proximity facilitates understandability (Boschma, 2005; Nooteboom, 2000). Whereas co-location is not necessary for exchanging knowledge—because of today's information and communication technologies—geographical proximity is still seen to *facilitate* the exchange (Boschma, 2005; Breschi and Lissoni, 2001b). This is because it simplifies face-to-face meetings, interaction, and trust building (Harrison, 1992).

In summary, from this literature on proximities, I have emphasized the importance of cognitive proximity, which can be translated in terms of the relatedness of

knowledge of individuals and firms. This will be further described in relation to industry dynamics in the following sub-section.

### 2.2.2 Agglomeration externalities and the role of relatedness

Studying industry dynamics requires, moreover, an understanding of the underlying structures of industries. There is a large strand of literature on agglomeration externalities that has studied what type of industry set-up is most beneficial for growth. This sub-section describes this literature in connection to relatedness.

Acknowledging that knowledge exchange is important for growth, a large part of the theorizing about agglomeration externalities has been concerned with determining which types of knowledge exchange are most beneficial. A distinction has especially been made between knowledge exchange that takes place *within* industries and knowledge exchange that takes place *between* industries. The advantages of the former are emphasized with regard to localization externalities (specialization), whereas the advantages of the latter are emphasized for Jacobs externalities (diversity).

Localization externalities—also known as specialization or Marshall-Arrow-Romer externalities based upon the work of of Marshall (1890), Arrow (1962), and Romer (1986)—are benefits that all local firms in the same industry enjoy. These externalities increase with the size (employees) of the industry and are therefore especially prevalent in regions (or cities) dominated by a few large industries. Actors in these settings are said to benefit from the externalities in terms of knowledge spillovers, labor market pooling, and facilitated access to specialized suppliers (Beaudry and Schiffauerova, 2009; Frenken et al., 2007; Glaeser et al., 1992). It is especially recognized that actors in the same industry can more easily exchange knowledge with each other and benefit from spillovers, which consequently facilitates innovation (Beaudry and Schiffauerova, 2009; Glaeser et al., 1992). In contrast to localization externalities, Jacobs externalities are based upon Jacobs's (1969) recognition of how growth in cities stems from diversity that is present in regions (or cities) containing a large variety of industries. Just like localization externalities, these settings are also argued to stimulate innovation, although in a different way: By the combination of a diverse set of resources and exchange of complementary knowledge, more innovative opportunities are likely to emerge (Beaudry and Schiffauerova, 2009; Feldman, 1999). Because of the likelihood of new combinations of knowledge from different industries, Jacobs externalities are likely to yield more radical types of innovations and product innovations than localization externalities, which instead are more associated with

incremental and process innovation (Frenken et al., 2007). The relative importance of localization and Jacobs externalities has been investigated in a large number of studies. All together these do, however, present contradictory results about of which of these types of externalities is the most beneficial for economic growth (Beaudry and Schiffauerova, 2009; de Groot et al., 2016).

This is a long debate with strong proponents on each side of the discussion. I follow a more recent strand of research, building on the seminal work by Frenken et al. (2007), which argued that regions with a *related variety* of industries are likely to be the most stimulating settings for growth.

The concept of related variety emphasizes that regions preferably should include a variety of industries that are *related*. The idea behind this is that actors who are cognitively related, rather than too cognitively similar or dissimilar, are likely to engage in more effective knowledge exchange, learning, and innovation (Boschma and Frenken, 2011a; 2011b). This argument is based on the recognition that knowledge exchange and learning most beneficially occur between actors when their cognitive distances are neither too small nor too large. If the cognitive distance is too small, not much knowledge spillovers will occur, since the actors already share similar knowledge. If the distance, on the other hand, is too large, it is difficult for knowledge exchange and learning to take place since the actors, due to their different knowledge bases, have difficulties understanding each other (Nooteboom, 2000). Thus, it is anticipated that actors with related knowledge, rather than too similar or dissimilar knowledge, would benefit more from each other in terms of knowledge exchange, learning, and innovation. Regions with actors in a related variety of industries are therefore argued to play a major role in stimulating the development of industries and the emergence of new ones (2011b; 2011a). As such, related variety and relatedness have received increasing attention in research in evolutionary economic geography (see for example Boschma, 2017), which is concerned with investigating asymmetric geographical distribution of development in the economy[6] (Boschma and Martin, 2007).

Studies on how related variety influences growth have especially investigated its effect on employment growth and productivity growth. A positive effect of related variety on employment growth has for example been found in the Netherlands (Frenken et al., 2007), Spain (Boschma et al., 2012), Sweden (Wixe and M. Andersson, 2016), and among small and medium-sized European regions (van

[6] By drawing upon theories and concepts in evolutionary economics (Boschma and Martin, 2007).

Oort et al., 2015) and in technologically advanced European regions in general (Cortinovis and van Oort, 2015). No effect of employment growth was however found in large and capital European regions (van Oort et al., 2015). The results are more mixed with regard to productivity growth: Positive results for related variety have been found in, for example, Italy (Quatraro, 2010), Spain (Boschma et al., 2012), and Sweden (using skill-relatedness) (Boschma et al., 2014), whereas negative results have been reported from the Netherlands (Frenken et al., 2007), Sweden (using the Standard Industrial Classification–based measure) (Wixe and M. Andersson, 2016), and small and medium-sized European regions. No effect of related variety on productivity growth has been reported in large and capital regions in Europe (van Oort et al., 2015).

The role of related variety and relatedness in the economy has also been recognized to be important for the emergence of new economic activities in regions or countries. This emergence of new activities is described in terms of local (often regional) diversification (2011b; 2011a; Neffke et al., 2011a), which is a branching process (Frenken and Boschma, 2007) where new activities emerge out of a combination of existing local related activities (Martin and Sunley, 2006). The first to quantitatively study this at the macro-level were Hidalgo et al. (2007), who mapped countries' *product space* using data on export products. Based upon co-occurrence analysis, they found, as expected, that countries' export portfolios tend to diversify into related products. At the regional level, Neffke et al. (2011a) studied regional industrial structures and what types of industries (that did not already exist in the regions) entered different regions. They also found support for the related branching thesis in that regions' industrial structures tend to diversify into related industries. The regional level seems especially important for the branching process, as recognized by Boschma et al. (2013). Using Spanish data, they found that the industrial structure at the level of the region plays a much larger role for emergence of new industries than does the industrial structure at the country level. Additional support for the related branching thesis has recently been found in other contexts (Boschma, 2017; Content and Frenken, 2016). However, there is also evidence of local unrelated diversification in Western European countries[7]

[7] Product trade data from West European (EU-27) and Eastern European countries (in European Neighbourhood Countries).

(Boschma and Capone, 2016) and high income counties[8] (Petralia et al., 2017), and countries with liberal market economies[9] (Boschma and Capone, 2015).

The concept of "relatedness" is closely aligned with and draws upon a strand of literature in economics and theory of the firm. At the level of the firm, related diversification was emphasized by Penrose (1959), who noticed that firms diversify into areas where they have related knowledge. Related diversification is argued to more likely occur than unrelated diversification, because firms that engage in related diversification draw upon existing capabilities, which gives them the chance to more effortlessly reap economies of scope (Farjoun, 1994; Markides and Williamson, 1994; Penrose, 1959; Teece et al., 1994). Quantitatively, this has been studied by, for example, Teece et al. (1994) using co-occurrence analysis of firms' industry affiliations. They found that U.S. manufacturing firms tended to diversify into related industries, where firm diversification was explained as a process whereby new activities were added to existing related activities. Other studies have also confirmed Penrose's recognition of related diversification, for example, that a firm's technological diversification (in terms of patents) is driven by relatedness (Breschi et al., 2003) or that firms tend to diversify into industries in which they have related skills (Neffke and Henning, 2013).

In summary, the literature reviewed in this section indicates that there is likely a positive effect of related variety and relatedness for growth. There are, however, some mixed empirical results in this regard, which indicates that the relationship is more complex than previously studied. Existing studies on the macro level or on diversification concern indirect relationships of how related knowledge influences economic development. More clarity about the role of relatedness of knowledge can be provided by micro-level studies on the actual knowledge transfer mechanisms that stimulate economic development. I have therefore chosen to investigate how and why industry experience of individuals matters for firms in general as well as for entrepreneurial ventures.

[8] Studying technological diversification using patent data from 65 countries.

[9] Using product trade data from 23 developed countries.

## *2.3* Labor mobility as a mechanism behind industry development

Labor mobility is acknowledged as a crucial mechanism (or channel) for knowledge transfer for firms, since it supplies new knowledge and stimulates learning and development (A. Malmberg and Power, 2005; Power and Lundmark, 2004; Song et al., 2003). This insight is close to my review above, which indicates that from a resource-based perspective, knowledge is regarded as the most important resource of the firm, and further, that it resides within individuals (Grant, 1996) and that organizations learn through their members (Cohen and Levinthal, 1990; Simon, 1991). Recruitment of new members therefore plays an important role in the organization's learning (Simon, 1991). In this thesis, labor mobility is seen as an important mechanism behind the dynamics and evolution of industries. This is because new combinations of knowledge (the foundation of innovations)—which foster industry dynamics—occur primarily as a result of knowledge creation and learning from interactions between different types of actors.

Despite the importance of labor mobility in the economy, research on industry dynamics and labor mobility has for long developed in fields separate from each other (Mamede, 2008). However, in recent years, these two fields have come together not least in evolutionary economic geography, where labor mobility has been studied for investigating evolutionary aspects of firms, industries, and the economy at large. To better understand the mechanisms behind industry development and the roles related industries play, I have chosen to focus on labor mobility in terms of knowledge sourcing by firms and the labor mobility of entrepreneurs.

At the level of the individual, "knowledge sourcing" has previously been defined by Gray and Meister (2004, p. 821) as individuals "intentionally access[ing] each other's expertise, experience, insights, and opinions". In similarity to the absorptive capacity concept—where the firm-level absorptive capacity to a large extent is based on the individual employees' absorptive capacities—I use the definition of knowledge sourcing at the level of the firm. Thus, in this thesis, I define knowledge sourcing as the firm's intentional accessing of knowledge, which I study in terms of the sourcing of labor.

### 2.3.1 Productive knowledge sourcing and prior industry experience

I propose to use the concept "productive knowledge sourcing" to study how productively firms make use of the knowledge they source. The reason for this is to add to the current literature, where researchers are searching for an answer to how related knowledge influences industry development through firm performance. There are different answers in this matter provided by the few studies that have focused on inflows of labor and the role of knowledge from related industries. However, whereas some found evidence that related knowledge through inflows of labor positively influences productivity growth (Boschma et al., 2009), others found that it depends upon industry characteristics and geographical proximity (Östbring and Lindgren, 2013; Timmermans and Boschma, 2013). An even more direct way of investigating how relatedness of knowledge influences industry development can be derived from the work by Holm et al. (2017) who studied *reallocation and destruction of skills* in connection to large company closures in the Danish shipyard industry. They used the change in wage of the worker to measure the extent of reallocation/destruction of the worker's skills. This builds upon the logic that the change in wage of the worker mirrors how much the new employer values the skills of the worker, and thereby to what extent the skills are reallocated. Destruction of workers' skills is consequently argued to occur for those who experience a decrease in wage. The more the wage increases the better reallocated the worker's skills are. The worker's wage level has previously also been found to reflect the productivity of the worker[10] (Hellerstein et al., 1999). As such, in this thesis I argue that the change in wage of the worker can be used as a proxy for productive knowledge sourcing of labor.

Previous research has investigated how wages change when workers switch jobs within and between industries. It has, for example, been found that displaced workers benefit from switching to new jobs in the same industry in comparison to those who switch to other industries (Neal, 1995). From the company closures in Denmark, Holm et al. (2017) found that skills were better reallocated when the workers left for new jobs in a spinoff in the same industry, and even more so when taking jobs in related industries. Eriksson et al. (2016) used the same method as Holm et al. (2017) to study the outcomes of workers who left the declining shipbuilding industry in Sweden and Germany. The results from Sweden showed that the extent of skill reallocation/destruction when the workers entered related

[10] Although women in general tend to earn less than men at the same level of productivity (Hellerstein et al., 1999).

or unrelated industries depended upon the time period. The development of the shipbuilding industry as well as the industries the workers entered was explained to be the reason for the different results.

In summary, I have combined the above streams of research to propose the following interpretation. Given the theories and findings discussed above, I propose it is likely that the productivity of knowledge sourced through labor is influenced by the type of knowledge (here in terms of industry origin), the context of the industry, the geographical proximity, and the time period of the study. Thus, I propose that the productivity of the knowledge sourced is not only likely to be a result of whether the knowledge of the worker is related or not, but also likely to be a result of other factors. I expect that the productivity of knowledge sourcing will especially depend on which phase in the industry life cycle the industry adheres to due to different knowledge requirement in different phases. The expectations in connection to the industry life cycle are presented in Section 2.4.

### 2.3.2 Entrepreneurship and prior industry experience

The labor mobility of entrepreneurs is a promising area to study for investigating the role of related knowledge in the economy. This is because entrepreneurship increases competition, innovation, and productivity and cultivates job-creation (Wennekers and Thurik, 1999). Since a large share of start-ups typically only survive a few years (Bartelsman, 2005), it is important to investigate which factors increase survival chances.

Literature on entrepreneurship suggests that the entrepreneur's prior knowledge largely influences the success of the venture. Several studies provide evidence that ventures with entrepreneurs who have pre-established industry-specific experience that they enter are likely to survive longer (M. Andersson and Klepper, 2013; Arribas and Vila, 2007; Brüderl et al., 1992; Dencker et al., 2009; T. Eriksson and Moritz Kuhn, 2006; Fontana and Nesta, 2010; Gimeno et al., 1997; Klepper, 2002), and benefit in terms of sales (see, for example, Delmar and Shane 2006) and generate larger entrepreneurial earnings (for example, Frederiksen et al. 2016).

However, recent advances from research about the role of related variety and relatedness in the economy give reasons to believe that related variety and relatedness should positively influence entrepreneurship, since they increase the chances of fruitful "cross-fertilization of ideas" (Basile et al., 2017, p. 3). Macro-level studies focused on agglomeration externalities (Basile et al., 2017; Howell et al., 2016; Neffke et al., 2012; Tavassoli and Jienwatcharamongkhol, 2016) find

support for this, but the other agglomeration externalities also seem to positively influence survival to a varying extent in the different studies. In terms of the extent to which related prior knowledge influences the performance of the entrepreneurial venture, the literature is scarce on evidence, and the methods used for classifying prior knowledge of the entrepreneur are diverse and based upon qualitative judgments. Some of the evidence that exists does, however, suggest that ventures' indeed benefit from being operated by entrepreneurs with related backgrounds in comparison to having entrepreneurs with unrelated or very similar backgrounds (Boschma and Wenting, 2007; Sapienza et al., 2004). In addition, Boschma and Wenting (2007) found that the ventures benefited particularly from being operated by entrepreneurs with prior experience from related industries in the initial growth phase of the industry life cycle.

In summary, my interpretation is that it is relevant to consider the industry life cycle when studying the role of relatedness in knowledge transfer activities. The following section therefore outlines differences that are likely to be prevalent in the different phases of the industry life cycle, as used in this thesis.

## 2.4 An industry life-cycle perspective

The literature on industry life cycles[11] highlights that firms' activities and knowledge requirements are likely to differ in different phases of the "life" of the industry. However, industry life cycles have not received much attention in the research about related variety and relatedness thus far. The studies on related variety and relatedness that do take on an industry life-cycle perspective put forth that related variety and other agglomeration externalities are likely to be prevalent to different extents in different phases of the industry life cycle (see Neffke et al. (2011b) and Ter Wal and Boschma (2011)), which is why I argue in this thesis that the role of relatedness of knowledge is likely to differ in different phases in the industry life cycle. Below follows first a review of phases traditionally found in industry life-cycle studies (infancy, growth, maturity, and decline) and thereafter an outline of renewal and interpretations connected to the role of related knowledge in this phase.

[11] Defined by Peltoniemi (2011, p. 349) aiming to "explain changes in the technological development and industry structure over the period that the industry ages".

### 2.4.1 The industry life cycle

In the initial infancy phase, when new technological opportunities emerge and the market volume is low, the preferences of the users are uncertain, which results in a variety of different products (Klepper, 1996). This phase is characterized by a high degree of product innovation, and the knowledge used comes from a wide range of external sources (Gort and Klepper, 1982). Explorative activities are therefore pronounced (Klepper, 1997), and knowledge requirements are heterogeneous (Neffke et al., 2011b). Jacobs externalities are argued to be especially prevalent in the infancy phase due to a need for a wide variety of knowledge inputs (Neffke et al., 2011b). As the industry grows and matures (Klepper, 1997), product designs eventually become increasingly standardized (Abernathy and Utterback, 1978; Utterback and Abernathy, 1975), which results in the emergence of dominant designs (Abernathy and Utterback, 1978), and innovation gradually shifts from product to process innovation (Abernathy and Utterback, 1978; Utterback and Abernathy, 1975). As opportunities become fewer and rivalry intensifies, a proactive entrepreneurial orientation, which entails exploitative activities,[12] becomes increasingly successful in more mature phases (Lumpkin and Dess, 2001). Thus, more specialized and industry-specific knowledge and resources typically become more important as the industry matures, which is why localization externalities are likely to become increasingly prevalent and positive in more mature phases (Neffke et al., 2011b).

The growth phase is typically characterized by mass entry during a relatively short period, followed by a shakeout when the number of producers sharply decline. The U.S. automobile industry, for example, grew to approximately 270 producers during its initial 14 years and lost 97% during the next 32 years. Klepper (2016, p. 15) summarized the shakeout as due to "a self-reinforcing mechanism operating through innovation that enables the richer to get richer, eventually forcing weaker firms to exit in a new industry". He did, however, acknowledge that not all industries experience shakeouts, which he explained in the following way: "[I]f innovation is rich enough to keep creating new segments then an innovative industry need not to experience a shakeout. But if developments occur that can cause producers in different segments to compete a shakeout can ensue" (Klepper, 2016, p. 61). Thus, whereas the shakeout process is likely to act through a self-reinforcing mechanism based on innovation, it also depends on heterogeneity and

[12] This refers to "incremental, minimal refinements to existing resources" (Lumpkin and Dess, 2001, p. 434).

the number of sub-segments present in the industry. Klepper (2016) did, however, also acknowledge that exogenous factors such as exogenous technological change and international competition play an important role. Such factors have not been recognized as important, at least, in evolutionary economic geography, where the ability to respond to exogenous change is emphasized as being largely dependent upon lock-ins (see, for example, Hassink (2007)). Although lock-ins can be positive in terms of network externalities and increasing returns, they are typically found to be problematic in old industrial districts. Negative lock-in can be described as a feature "whereby a region or locality becomes over-reliant on, or dominated by, a particular self-reinforcing industrial-technological path that renders the regional or local economy increasingly structurally and technologically rigid, restricting thereby its capacity to adapt to changing competitive forces ('the weakness of strong ties' argument)" (Martin and Sunley, 2010, p. 65). The extent of lock-in has, for example, been recognized to play a role in the German textile industry's response to the international competition from low-wage countries. In the region Westmünsterland, the relatively weak lock-ins were, for example, explained as having facilitated renewal of the industry in the region (Hassink, 2007). Renewal, though, is, a phase that is missing theorizing in the industry life-cycle literature, which is why, in the following sub-section, I integrate theories from literature on cluster life cycles and path development.

In summary, I derive from the literature that the relative usefulness of different types of knowledge—in terms of the level of relatedness—by actors in different industries is likely to largely depend on the heterogeneity of the knowledge required connected to the industry life-cycle phases the industries adhere to. I also interpret the transitions between different phases to depend on self-reinforcing mechanisms, opportunities present, and institutional factors that affect lock-in.

### 2.4.2 Renewal

Industry and cluster[13] life-cycle theories have traditionally modelled the developments through different stages—infancy, growth, maturity, and decline—in a sequenced and deterministic manner. Since paths of industries and clusters can take other directions, criticism has been raised towards the deterministic models (see for example Menzel and Fornahl (2010), Martin and Sunley (2011), Neffke et al. (2011b), Trippl et al. (2014), Fornahl et al. (2015)). To allow for

[13] Geographically concentrated and interconnected firms and institutions in a specific field which can span several industries (1998).

deviances from the sequenced paths, Menzel and Fornahl (2010) made an important contribution by introducing a feedback loop through which clusters can re-direct their path to an earlier life-cycle phase and thereby rejuvenate themselves. In Menzel and Fornahl's (2010) model, the development of the cluster life cycle mainly depends on knowledge heterogeneity. They described the transition between decline and the entering of a new growth phase in the following way (Menzel and Fornahl, 2010, pp. 218–219):

> The cluster declines if its heterogeneity cannot be sustained. If the heterogeneity increases again, it moves "back" in the cycle and enters a new growth stage.

Menzel and Fornahl (2010) emphasized that a cluster declines if it becomes too narrowly specialized and that it can be rejuvenated if heterogeneity is increased, which can happen if the cluster integrates new knowledge and technologies. This takes form of (i) incremental adaptation, (ii) renewal by the integration of new related technologies, or (iii) transformation by entering entirely new fields (Menzel and Fornahl, 2010). The two latter transitions fit into Chapman et al.'s (2004, p. 383) definition of industry renewal, which entails a "significant change of the existing trajectory of development", whereas the former refers to adjustment through the "extension of established trends". In contrast to transformation, Menzel and Fornahl (2010) explicitly emphasize the integration of *related* technologies in renewal. Similarly, Isaksen and Trippl (2014, p. 1) describe path renewal as the "branching of existing industries into different but related ones", based on the literature on related branching mentioned previously. Thus, more radical types of changes of trajectories are likely to be concerned with more unrelated activities, whereas less radical changes of trajectories are likely to be concerned with more related activities (Neffke et al., 2017a). Based on this, I interpret renewal as differing from infancy (or path creation) in that it is less radical, since the explorative activities are likely to be more focused upon recombinations of related knowledge with the knowledge base pre-existing in the industry. I therefore interpret the importance of related knowledge to be comparatively more pronounced in renewal than in infancy.

### 2.4.3 Expectations of the role of relatedness of knowledge connected to the industry life cycle

Based on the literature reviewed, my proposition and interpretation is the following. Diversity is likely to favor industries in the infancy phase of the industry life cycle due to the explorative and innovative nature of this phase where firm

requirements are characterized by heterogeneity. New combinations of unrelated knowledge are thereby likely to be important. As the industry grows, the knowledge requirements become more homogeneous than in the infancy phase due to increasing standardization and a larger focus on exploitation. The growth phase is thereby likely to subsequently shift toward a larger importance of knowledge that is more related. Related variety would consequently be especially beneficial in the growth phase. Well into the maturity phase, firms are likely to be specialized and engage comparatively more in exploitative activities. Thereby, firms' knowledge requirements are likely to be more homogeneous, which is why firms would benefit comparatively more from industry-specific knowledge and localization externalities in the maturity phase. When mature industries have entered into the renewal phase—where the existing knowledge base is likely to be replaced and recombined with new knowledge—explorative activities and innovation become pronounced. Since this phase is likely to be less radical due to the recombinations with the pre-existing knowledge base, firms in industries in renewal are likely to benefit more from related knowledge and settings with related variety.

All in all, I have previously explained that the prior knowledge of workers and entrepreneurs is likely to be influential for the firm or venture. Connecting this to the role of relatedness of knowledge and theories on industry life cycles, there are reasons to believe that the role of relatedness of knowledge of workers and entrepreneurs is likely to vary throughout the industry life cycle. Due to the relative importance of different types of knowledge—in terms of the level of relatedness—in the different phases, I expect the pattern explained in this sub-section to be observed for how productively firms make use of the knowledge they source. Thus, in line with this pattern, the relatedness of the knowledge sourced is likely to influence productivity differently in different phases of the industry life cycle. The theories about requirement of different types of knowledge throughout the industry life cycle are likely to also apply to the way prior knowledge of the entrepreneur influences the venture's survival chances. In this regard, I interpret the influence of relatedness of the entrepreneur's knowledge on the survival chances of the venture as likely to vary in different phases of the industry life cycle, in line with the patterns explained above.

In the following section, I contextualize the industry studied in this thesis and describe its two sub-industries in terms of the industry life-cycle phases they have been subject to during the period of study. This serves as a foundation for the way I later analyze my results in connection to the theories I have presented in this section.

# 3 Empirical setting: The textile industry in Västra Götaland

This section contextualizes the textile industry, and its development, in the West Swedish region Västra Götaland. The first part, Section 3.1, describes how Västra Götaland (VG) emerged as a center for the textile industry in Sweden and focuses on important locations where the industry agglomerated. The crisis in the 20th century and the transformation that followed is thereafter described in Section 3.2. In Sections 3.3–3.5 particular attention is devoted to the development of Manufacturing of textiles and Wholesale and retail trade of textiles in VG between 1990 and 2010, in terms of descriptive statistics of employment, structure of workplaces, sub-industries, and entries and exits of entrepreneurial ventures.

## 3.1 The emergence of Västra Götaland as a center for the textile industry in Sweden

The making of textiles has a long tradition in human history. Yarns and textiles from wool, linen, cotton, and silk were produced thousands of years before metals were taken into use (Cele, 2007). For a long time, textile production took the form of handicrafts made in people's homes. Trade of those textile products was arranged by farmers or merchants who traveled between farms, marketplaces, and cities and sold either their own products or products made by others. The people in Sjuhärad (see Figure 3.1 for a geographical overview) especially exchanged textiles, animal products, and forgings for cereals, salt, and iron (Berglund, 2005). The trading farmers or merchants, often called "knallar", have a special place in the history of the textile industry in Sjuhärad and VG. Nowhere else in Sweden were the handicraft merchants as mobile as in the Sjuhärad-area. This is attested, for example, by the comparatively numerous forts that historically have been present in the region, which back in time served to control the trade and bring in taxes from the country people. In the 17th century the trade of textiles grew larger in the region. However, the merchants in the countryside in Sjuhärad were known for evading the tariffs when trading goods outside their locality. This was bothersome


*Figure 3.1 Geographical overview of Västra Götaland, its four sub-regions, and municipalities including the cities of Gothenburg and Borås* [14]

for the Swedish government since it was in large need of money that could finance the contemporary military operations. To gain control over the trade, the government requested the foundation of a new city for the country people in Sjuhärad. In 1621, Borås was founded for this purpose. To attract the merchants of the countryside to register in the cities and pay taxes there, the government gave them extended rights to trade goods in other geographical locations. Many did, however, circumvent the system by register themselves in Borås and continuing their business as usual in the countryside, without entering the city to pay the tariffs (Andréasson, 2013). In the mid 17th century, dyeing of textiles became industrialized (Cele, 2007) as a result of the improved economic situation that made people increasingly able to afford colored products. This demand for colored products was recognized by the government, which gave permission for the establishment of dyeing plants only in cities in order to create incentives for the anarchistic textile entrepreneurs and traders to finally move to the cities. This seemed to be a successful strategy (Andréasson, 2013). In the 1690s the first plant

[14] Own version (names and dashed lines) based on template from RegionFakta.com (http://www.regionfakta.com/Vastra-Gotalands-lan/).

in Sweden for textile dying was founded in Borås by Abraham Langlet (Cele, 2007). More dyeing plants were founded in Borås and during the 18th century the city became an increasingly important center for trade (Andréasson, 2013).

In the beginning of the 19th century cotton became more and more popular in Sweden, where, to a large extent, it replaced linen and wool. Cotton was cheaper to use in the manufacturing of textiles since it was easier to spin and weave. The demand from the consumers was high for cotton-based products because of the favorable price and the appealing finish. In the 1840s about 78% of all cotton was woven in the homes. Just about 30 years later, in the 1870s, cotton weaving was almost exclusively carried out in industrial production. Entrepreneurs who could afford significant investments built large-scale production plants where the power source (first in the form of a waterwheel, and thereafter as the steam engine) could supply all the machines with electricity (Andréasson, 2013). This industrial revolution was a result of important mechanical innovations from England that took place in the mid-18th century (Cele, 2007). The textile industry pioneered the industrial revolution in Sweden (Cele, 2007; Sandberg and Waara, 2014), and in the mid-19th century the textile industry employed as many as half of all industrial workers in Sweden (Cele, 2007). The textile industry grew large in Borås in the end of the 19th century when more and more plants located there to access the river Viskan as the source of water supply (Andréasson, 2013). In the second industrial revolution that followed, the industry was characterized by increasing automation, rationalization, and standardization. The conveyor-belt assembly line introduced by Ford, for example, was adopted to increase efficiency, and large batches were produced to decrease unit costs (Andréasson, 2013).

During the 19th century, the industry expanded rapidly due to the mechanical innovations previously mentioned. However, in the beginning of the 19th century the tariff on imported cotton-based fabrics was abandoned, which lead to increasing competition from international actors. As a result, the people of Borås aspired to develop the craftsmanship and use new technologies to stay competitive within textiles. The people therefore requested the establishment of an education in textiles. This resulted in the founding of a technical elementary school in 1856 and an additional annex for education in textiles, “Väfskolan”, in 1866. As Väfskolan and the textile industry expanded over the years, the former turned, in 1936, into a textile institute. It started offering engineer degrees in textiles, filature technique, design, and so forth. This laid the foundation to what later became The Swedish

School of Textiles[15] at University of Borås (Andréasson, 2013).

In Sweden, the textile industry has historically also been strong in the Gothenburg region (a sub-region to Västra Götaland, see Figure 3.1). In particular, the harbor in Gothenburg has been cited as an important reason for the concentration of the textile industry in the region. In the early days, in the mid-17th century, making of ropes was an important area, and during the 18th century a number of firms in the region also focused on manufacturing of sails. Because of the harbor, Gothenburg was also an important location for trade with other countries. Cotton was imported through the harbor in Gothenburg and the tradesmen learned about new technological developments of machines used for manufacturing of textiles on their business trips to other countries. In the beginning of the 19th century, this resulted in the emergence of plants with manufacturing of cotton-based textiles. The textile industry grew strong in Gothenburg, where it was the dominating industry in the beginning of the 20th century (Gråbacke and Jörnmark, 2008).

## 3.2 Crisis and transformation

In the 1950s, around 117000 people were employed in the textile industry throughout Sweden. Somewhat fewer than half of those were working with clothing and the others with other types of sewn products as well as upstream products like manufacturing of yarn, fabrics, tricot, and the like (Gråbacke and Jörnmark, 2008). In Borås, about 70% of the workforce were working in the textile industry around that time (Olsson, 2005a). This came, however, to change. Due to increased global competition, especially from low-wage countries in Asia, the Swedish textile industry has experienced a sharp decline, whereby it lost about 90%–95% of its employees between 1950 and 2005 (Gråbacke and Jörnmark, 2008). A number of factors such as higher wages, stronger free trade, dominating large chains, and problems in responding to new customer demand weakened the textile industry in Sweden in particularly compared to the textile industry in other European countries (Cele, 2007; Gråbacke and Jörnmark, 2008). To respond to the crisis, many Swedish firms tried to adopt an American strategy, which implied production of large batches to reduce the unit costs. For many of the firms that kept their manufacturing located in Sweden, this strategy failed as they miscalculated the ever-increasing competition from the Asian producers (Gråbacke and Jörnmark, 2008). In the 1960s and 1970s, firms started to relocate their

[15] Which today has about 900 students (The Swedish School of Textiles, 2018).

manufacturing to other countries, especially to Finland and Portugal (Cele, 2007; Gråbacke and Jörnmark, 2008), which were popular from a free-trade and wage perspective. This made the competition on the Swedish market even more problematic for the firms that had their manufacturing located in Sweden (Gråbacke and Jörnmark, 2008). The crisis led, in the 1970s, to protectionist political actions aimed at saving the textile industry in Sweden, for example, the introduction of tolls and subsidies, and public procurement of failing firms. One of those firms was Eiser AB (founded in 1913 under the name "Sveriges Förenade Trikåfabriker"), which was one of the largest firms in the textile industry in VG. The publicly owned textile firms were, however, sold to private firms in 1983–1986 (Cele, 2007; Gråbacke and Jörnmark, 2008; Olsson, 2005b). Translated from Swedish, Gråbacke and Jörnmark (p. 13) describe the period that followed:

> In the 1980s one agreed that the protectionist politics had reached its end. The viable parts of Eiser AB were privatized, and in the beginning of the 1990s all subsidizing in the area ceased, and for a period Sweden had, before entering the EU, total free trade with regard to textile products. During the same period, one can also see that the firms that had survived were developing in a direction towards what has been described as the Swiss path: through product development increase the possibilities of commanding a higher price for the product, which covers the higher wage costs.

Thus, government support to the textile industry ceased in the early 1990s and the firms had begun to adopt the Swiss strategy with a focus on product development and differentiation. Although the transition into more differentiated products started earlier for some firms (Gråbacke and Jörnmark, 2008), a strong development within *technical* and *smart textiles* (see definitions in Appendix I) with regard to functionality, new materials, new areas of use, and sustainability characterized the two decades that followed 1990 (Cele, 2007). An example of this development is the organization Smart Textiles—part of the University of Borås—which was established in 2006. It is a collaborative center for innovation that gathers together firms, universities, research institutes, incubators, and other actors for the purpose of developing innovations, building prototypes, conducting research, and so forth (see Smart Textiles 2018). The collaborations are highly interdisciplinary, as they focus on health, medicine, sports, sustainable textiles, architecture, interiors, composites, and electronics among other things and involve firms and actors from a wide range of industries (see Smart Textiles 2013, 2016, and 2018). Since 2006 Smart Textiles has hosted over 450 research- or firm-based

projects (Smart Textiles, 2018), which exemplifies the innovative climate of the textile industry in the region during the period. [16]

Among firms focused on manufacturing of textiles and cloths that still had labor-intensive production in Sweden in the beginning of the 1990s, the Baltic countries became—after the liberation of Eastern Europe—a popular target for the re-location of the production (Cele, 2007; Gråbacke and Jörnmark, 2008). This relocation of labor resonates with the large employment decline in Manufacturing of textiles in VG during 1990–2010. As seen in Figure 3.2, Manufacturing of textiles in VG declined by as much as 74% during the period (my own calculations). Since most of the production came to be located abroad, the clothing firms are today more focused on knowledge-intensive activities such as purchase of materials, logistics, marketing, design, and product development (Gråbacke and Jörnmark, 2008). Many of these firms adhere to Wholesale and retail trade of textiles, which based on my own calculations has grown by 22% in terms of the number of employees between 1990 and 2010 (see Figure 3.2[17]). Since the 1980s, increased digitalization has facilitated firms' customer contacts and coordination with suppliers, which has especially been prevalent for firms with mail-order business. Since the 2000s, this development has resulted in growth in e-commerce of textile products (Olsson, 2005b). In 2012 the e-commerce represented 11% of the turnover of the sales of clothes and shoes in Sweden (GS1 and HUI Research, 2013).


*Figure 3.2 Number of employees in the textile industry in Västra Götaland 1990–2010 (all employees excluding students and ones with below half-time wage)*

[16] Some of these projects also involve actors from other regions.
[17] The financial crisis possibly explains the relatively small temporary decline in 1990–1993.

The development of Manufacturing of textiles and Wholesale and retail trade of textiles in VG is further explored in the following sections, using descriptive statistics. Details connected to the data and methods are provided in Section 4.

## 3.3 Industry structure through employment in Manufacturing of textiles in VG 1990–2010

Table 3.1 shows the employment in Manufacturing of textiles in VG in 1990 and 2010. The VG region is broken down into Borås, the rest of Sjuhärad, and the Gothenburg region (Gbg region), since these, as previously described, are known as having been important locations for the textile industry in VG. It is derived from Table 3.1 that both the employment and share of total employment were larger in Borås and Sjuhärad than in the Gothenburg region and the rest of VG, both in 1990 and in 2010. Compared to the rest of Sweden, Borås and the rest of Sjuhärad (Sjuhärad excluding Borås) also had a higher share of total employment working in Manufacturing of textiles in VG. In terms of the difference in employment between 1990 and 2010, Manufacturing of textiles has declined in all locations shown in Table 3.1.[18] The decline was, however, slightly less severe in the rest of Sjuhärad. Interesting to note is that the Gothenburg region, which once was one of the important locations for Manufacturing of textiles, had only 253 employees in this sub-industry in 2010, which was 0.07% of its total employment.

*Table 3.1 Employment in Manufacturing of textiles in Västra Götaland and the rest of Sweden, 1990 and 2010 (all employees excluding students and ones with below half-time wage)*

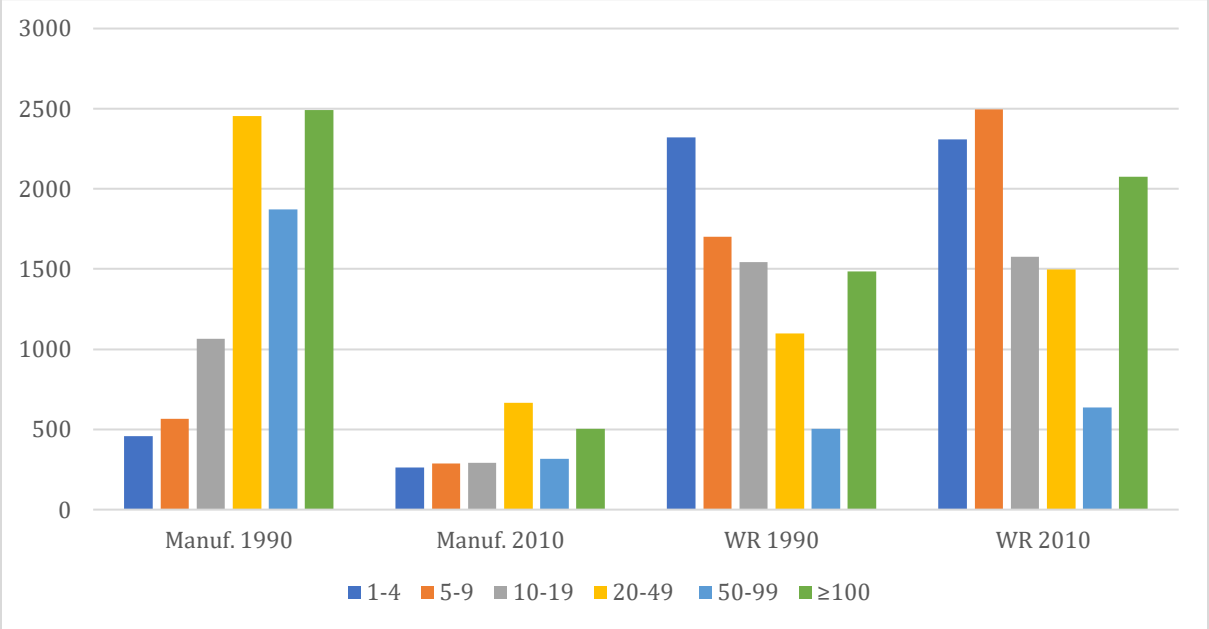
| | | Employment | | Share of total employment | | |
|---|---|---|---|---|---|---|
| | | 1990 | 2010 | Share 1990 | Share 2010 | Share 2010/ Share 1990 |
| VG | Borås | 2950 | 617 | 0.0703 | 0.0135 | 0.1915 |
| | Rest of Sjuhärad | 3569 | 1197 | 0.1188 | 0.0386 | 0.3250 |
| | Gbg region | 1133 | 253 | 0.0036 | 0.0007 | 0.1885 |
| | Rest of VG | 1255 | 257 | 0.0066 | 0.0014 | 0.2090 |
| | VG in total | 8907 | 2324 | 0.0155 | 0.0037 | 0.2369 |
| Rest of Sweden | | 10948 | 4132 | 0.0040 | 0.0014 | 0.3418 |

[18] From additional data it is found that the decline in Manufacturing of textiles in the rest of Sweden was comparatively mild (57.6%) in the Stockholm–Solna region (2008 definition excluding Trosa and Gnestad). In 2010, this part represented 7.5% of the employment in Manufacturing of textiles in Sweden.

As seen in Table 3.2 and Figure 3.3, the employment in Manufacturing of textiles in VG has diminished in all sizes of workplaces, although the larger workplaces signify the largest decline. A similar pattern can be found for the number of workplaces in Manufacturing of textiles in VG, where numbers of workplaces of all sizes have declined, and especially the larger ones have become much fewer.

*Table 3.2 Number of employees and number of workplaces per size of workplace in Manufacturing of textiles in Västra Götaland (all employees excluding students and ones with below half-time wage)*

| | Number of employees | | | | | Number of workplaces | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | | 2010 | | | 1990 | | 2010 | | |
| Size | Freq. | Percent | Freq. | Percent | Freq. 2010/ Freq. 1990 | Freq. | Percent | Freq. | Percent | Freq. 2010/ Freq. 1990 |
| 1–4 | 457 | 5.1 | 261 | 11.2 | 0.6 | 230 | 45.2 | 142 | 59.7 | 0.6 |
| 5–9 | 566 | 6.4 | 289 | 12.4 | 0.5 | 84 | 16.5 | 43 | 18.1 | 0.5 |
| 10–19 | 1067 | 12.0 | 290 | 12.5 | 0.3 | 76 | 14.9 | 23 | 9.7 | 0.3 |
| 20–49 | 2453 | 27.5 | 665 | 28.6 | 0.3 | 78 | 15.3 | 22 | 9.2 | 0.3 |
| 50–99 | 1871 | 21.0 | 315 | 13.6 | 0.2 | 26 | 5.1 | 5 | 2.1 | 0.2 |
| ≥100 | 2493 | 28.0 | 504 | 21.7 | 0.2 | 15 | 3.0 | 3 | 1.3 | 0.2 |
| Total | 8907 | 100 | 2324 | 100 | 0.3 | 509 | 45.2 | 142 | 59.7 | 0.6 |




Manuf, Manufacturing of textiles; WR, Wholesale and retail trade of textiles

*Figure 3.3 Number of employees per size of workplace in the textile industry in Västra Götaland (all employees excluding students and ones with below half-time wage)*

In line with the literature reviewed on the textile industry in Sweden, the largest employment decline can be found in labor-intensive areas also for the period 1990–2010. Manufacture of clothing and other wearing apparel and accessories (182) and Textile weaving[19] (172), which were the two parts that dominated the

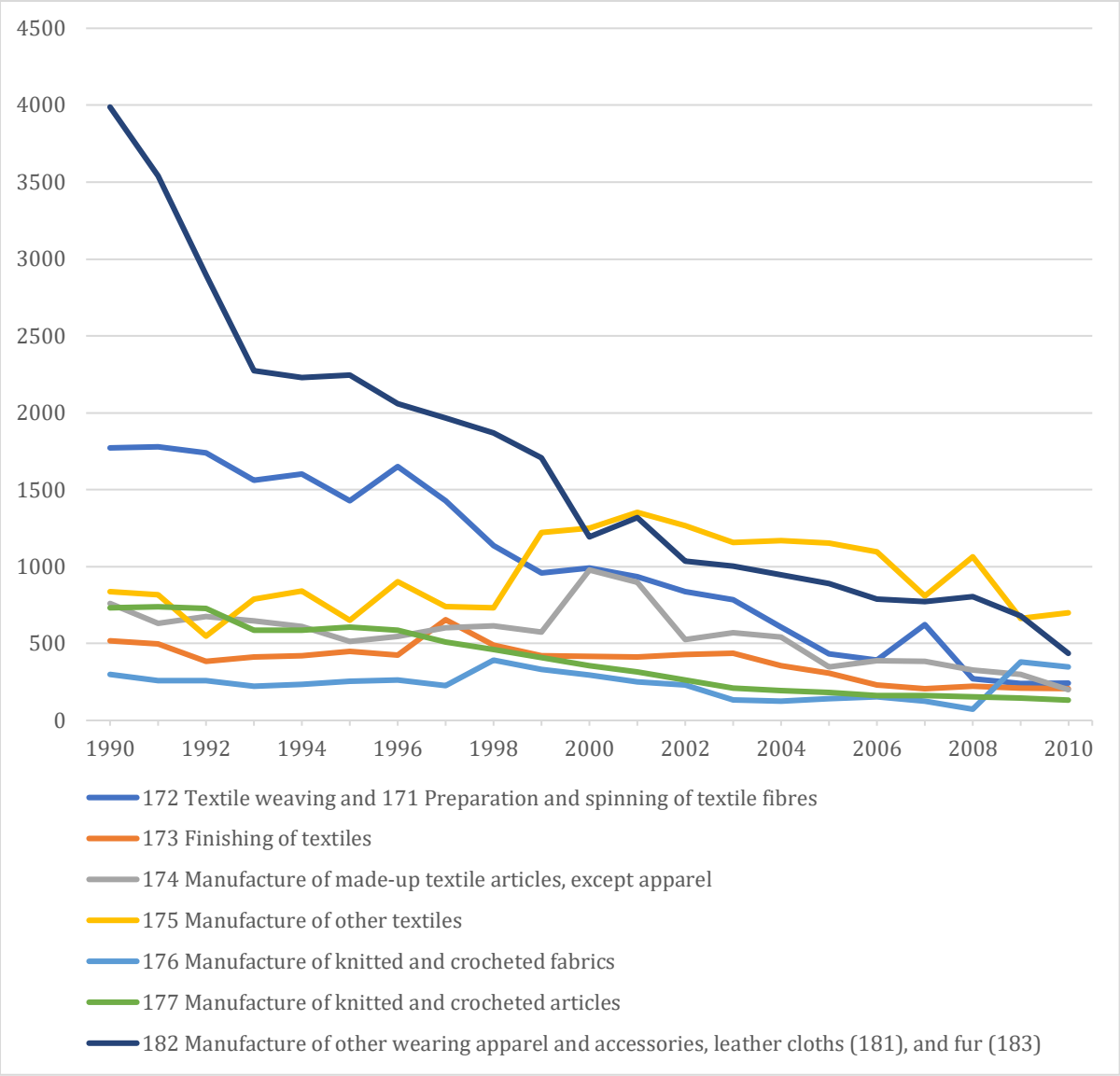



*Figure 3.4 Number of employees in 3-digit industries in Manufacturing of textiles in Västra Götaland 1990–2010 (all employees excluding students and ones with below half-time wage)*

[19] *Manufacture of leather clothes* (181) and *Dressing and dyeing of fur; manufacture of articles of fur* (183) are here presented in group together with *Manufacture of other wearing apparel and accessories* (182) as the two former include low numbers of workers. *Preparation and spinning of textile fibers* (171) is grouped with *Textile weaving* (172) for the same reason. This grouped presentation of the data is due to secrecy reasons connected to the data. See Section 4 for further details on the data used.

textile industry in VG in 1990 were subject to the most dramatic decline (see Figure 3.4). A significant decline can also be seen in *Manufacture of knitted and crocheted articles* (177) *and Manufacture of made-up textiles*[20] (174). *Manufacture of knitted and crocheted fabrics* (176), however, stands out as an exception where the number of employees was higher at the end of the period than in the beginning. The development of *Manufacture of other textiles* (175) also stands out as an exception, as it ended up with an employment rate in 2010 comparable to that in 1990. Two of the parts of *Manufacture of other textiles* (175) that have had the most sustainable development are *Manufacture of ribbon, trimmings and lace* (17541) and *Manufacture of various other textiles n.e.c*. (17549). These both adhere to the definition of *Manufacture of technical textiles.*[21] Also, *Manufacture of carpets and rugs* (17510) can be seen in the data to have had a sustainable development during the period (where the workforce has decreased only by a few percent). Altogether, the changes in the industry composition during the period to a large extent verify the qualitative indications of an ongoing renewal from labor-intensive to more knowledge-intensive manufacturing. It shall, however, be noted that some of the development within technical textiles is not covered in the data on Manufacturing of textiles due to the fact that it is an interdisciplinary field, within which many firms are affiliated to other industries.

## 3.4 Industry structure through employment in Wholesale and retail trade of textiles in VG 1990–2010

With regard to the distribution of Wholesale and retail trade of textiles in different parts of VG, most of the employment during the period was concentrated in the Gothenburg region (see Table 3.3). Borås does, however, stand out as the place in VG with the largest share of employment in Wholesale and retail trade of textiles. Compared to the rest of Sweden, the share of employment in Wholesale and retail trade of textiles was higher in Borås, the rest of Sjuhärad, and the Gothenburg region. The employment development of Wholesale and retail trade of textiles, in terms of share of total employment between 1990 and 2010 was, however, stronger in the rest of VG. Still, on average, the employment development in

[20] Manufacture of made-up (sewn) textile articles, except apparel
[21] In the SNI07 industry classification system (This thesis is however built on the earlier SNI02 classification system.)

Wholesale and retail trade of textiles has been stronger in the rest of Sweden than in VG.[22]

*Table 3.3 Employment in Wholesale and retail trade of textiles in Västra Götaland and the rest of Sweden in 1990 and 2010 (all employees excluding students and ones with below half-time wage)*

| | | Employment | | Share of employment | | |
|---|---|---|---|---|---|---|
| | | 1990 | 2010 | Share 1990 | Share 2010 | Share 2010/ Share 1990 |
| VG | Borås | 2190 | 2515 | 0.0522 | 0.0549 | 1.0514 |
| | Rest of Sjuhärad | 748 | 840 | 0.0249 | 0.0271 | 1.0883 |
| | Gbg region | 4145 | 5422 | 0.0133 | 0.0147 | 1.1043 |
| | Rest of VG | 1569 | 1815 | 0.0082 | 0.0097 | 1.1807 |
| | VG in total | 8652 | 10592 | 0.0151 | 0.0168 | 1.1113 |
| Rest of Sweden | | 26488 | 34241 | 0.0096 | 0.0112 | 1.1709 |

The largest increase in employment in Wholesale and retail trade of textiles in VG can be attributed to the larger workplaces (except from those with 5–9 employees, which represented the largest increase), as seen in Table 3.4 and Figure 3.3. However, in terms of number of workplaces, those with 100 employees or more were as numerous in 2010 as in 1990, which shows that the largest workplaces at the end of the period were even larger than the largest workplaces at the beginning of the period. The other size segments of workplaces followed a development similar to that of the employment development, where those with 5–9 employees and 20–99 employees represented the largest increase. Interesting to note is that the number of workplaces was lower in 2010 than in 1990. This decline in number of workplaces can be attributed to the smallest segment (1–4 employees), although the number of employees in that segment was similar both years. The workplaces in the smallest segment were thereby larger in 2010 than they were in 1990.

Figure 3.5 shows that the employment growth can be attributed primarily to *Wholesale of clothing and footwear* (51420) and *Retail sale of women's clothing* (52423). However, *Retail sale of home furnishing textiles* represented the largest change in employment, as it grew by 130% during the period. Although most of the

[22] Additional data reveal that this strong development in the rest of Sweden mainly can be attributed to the Stockholm-Solna region (the 2008 definition excluding Trosa and Gnestad), which in 2010 represented 31.4 % of the total number of employees in Wholesale and retail trade of textiles in Sweden.

5-digit industries in Wholesale and retail trade of textiles have had a positive development in VG, a few have developed negatively or slightly negatively. The largest percentage employment decline can be found in *Retail sale of furs*[23] (52425) followed by *Retail sale of textiles* (52410).

*Table 3.4 Number of employees and number of workplaces per size of workplace in Wholesale and retail trade of textiles in Västra Götaland (all employees excluding students and ones with below half-time wage)*

| | Number of employees | | | | | Number of workplaces | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | | 2010 | | | 1990 | | 2010 | | |
| Size | Freq. | Percent | Freq. | Percent | Freq. 2010/ Freq. 1990 | Freq. | Percent | Freq. | Percent | Freq. 2010/ Freq. 1990 |
| 1–4 | 2321 | 26.8 | 2309 | 21.8 | 1.0 | 1202 | 73.1 | 1071 | 64.6 | 0.9 |
| 5–9 | 1701 | 19.7 | 2495 | 23.6 | 1.5 | 270 | 16.4 | 388 | 23.4 | 1.4 |
| 10–19 | 1542 | 17.8 | 1575 | 14.9 | 1.0 | 118 | 7.2 | 123 | 7.4 | 1.0 |
| 20–49 | 1100 | 12.7 | 1498 | 14.1 | 1.4 | 38 | 2.3 | 56 | 3.4 | 1.5 |
| 50–99 | 504 | 5.8 | 639 | 6.0 | 1.3 | 7 | 0.4 | 10 | 0.6 | 1.4 |
| ≥100 | 1484 | 17.2 | 2076 | 19.6 | 1.4 | 9 | 0.6 | 9 | 0.5 | 1.0 |
| Total | 8652 | 100 | 10592 | 100 | 1.2 | 1202 | 73.1 | 1071 | 100 | 0.9 |

[23] Due to secrecy reasons of the data, *Retail sale of furs* (52425) is included in *Retail sale of men's, women's and children's clothing, mixed* (52421) because of the low number of employees in the former.

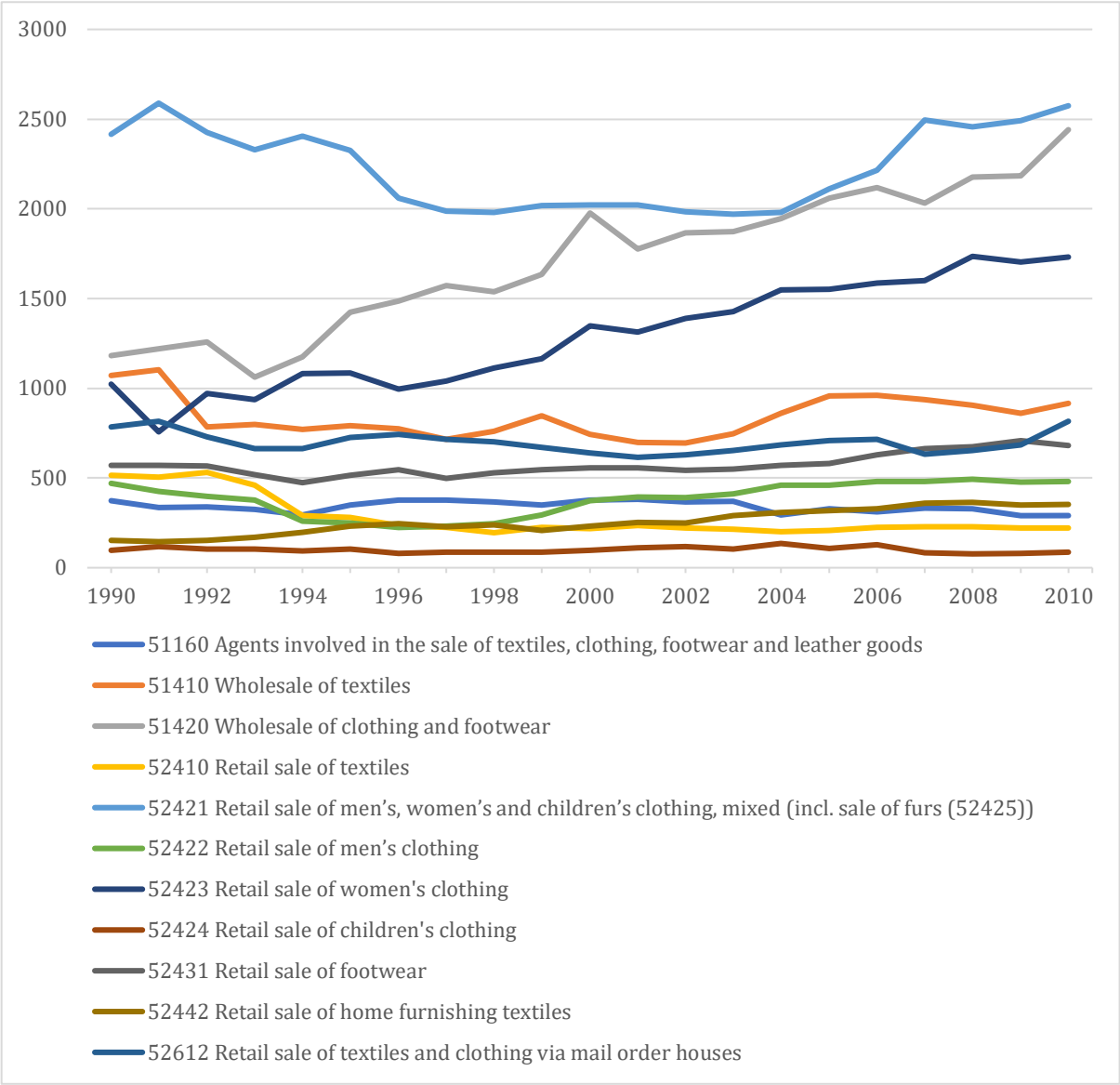



*Figure 3.5 Number of employees in sub-industries to Wholesale and retail trade of textiles in Västra Götaland 1990–2010 (all employees excluding students and ones with below half-time wage)*

## 3.5 Entries and exits of entrepreneurial ventures and synthesis

The descriptive statistics in the previous sections showed large differences between Manufacturing of textiles and Wholesale and retail trade of textiles in terms of the development of numbers of employees and workplaces. It was, for example, found that the number of employees in Manufacturing of textiles in VG declined by 74% between 1990 and 2010, whereas the employment in Wholesale and retail trade of textiles grew by 22% during the same period. A similar pattern was found for Manufacturing of textiles in VG in terms of number of workplaces,

which decreased by 70%. The largest decrease was found in the segments with the larger workplaces, whereas the smallest-sized segment, with 1–4 employees, represented the most modest decline. The latter did, however, still decline by 40% both in terms of both number of employees and number of workplaces. For Wholesale and retail trade of textiles, on the other hand, all segments increased in terms of number of employees. The smallest-sized segment (1–4 employees) did, however, decrease by 10% in terms of number of workplaces, although the number of employees stayed at a similar level. It is possible that the lack of employment growth in this segment is due to growth of the workplaces, since most of the other larger segments' employment increased during the period. The total number of workplaces did, however, decrease during the period, which potentially can be explained by an environment where mergers and acquisitions have taken place, and/or in which firms have chosen to close some of their workplaces in favor of focusing their operations in fewer locations with a larger number of employees. Another possibility is that smaller workplaces have closed down due to fiercer competition from larger ones. These possible reasons might be an indication that the sub-industry has been subject to maturity over the period. However, to gain a more nuanced idea of the development of this sub-industry during the period, it is relevant to study the number of entries and exits of entrepreneurial ventures, since this gives an indication of the opportunities present. As entries and exits (studied in terms of appearance/disappearance of the organization number) can be due to ID changes or mergers and acquisitions, the statistics below exclude such cases (see Section 4 for more details).

Table 3.5 provides statistics on the entry and exit rates of entrepreneurial ventures in the textile industry in VG for the study period 1990–2010 as well as for 1995–2010, and Figures 3.6 and 3.7 present the yearly number of entries and exits during the whole period. Apart from being the study period of Paper III, the latter time period excludes the first years, which partly were characterized by financial crisis. The statistics therefore differ to some extent between these time periods. For Wholesale and retail trade of textiles in VG, it is found that there were 4.1% more entries than exits between 1990–2010 and 5.7% more entries than exits if the years 1990–1995 are disregarded. This indicates that there was some extent of growth during the period. However, the entry rate is not comparable with the high rates in typical growth phases (see, for example, Boschma and Wenting, 2007, and Klepper, 2016). This, together with the fact that the industry structure changed somewhat towards larger workplaces, indicates that the sub-industry rather was subject to a smaller growth phase in maturity. In this thesis I therefore classify Wholesale and retail trade of textiles in VG as adhering to the maturity phase of the industry life cycle in 1990–2010.

*Table 3.5 Statistics for entries and exits of entrepreneurial ventures (see details in section 4) in the textile industry in Västra Götaland 1990–2010*

| | 1990–2010 | | | | 1995–2010 | | | |
|---|---|---|---|---|---|---|---|---|
| | M | | WR | | M | | WR | |
| | Entries | Exits | Entries | Exits | Entries | Exits | Entries | Exits |
| Number entries and exits of entrepreneurial ventures | 610 | 700 | 2189 | 2102 | 458 | 475 | 1557 | 1473 |
| Share (Number of entries or exits/Sum of yearly number of entrepreneurial ventures) | 0.0690 | 0.0792 | 0.0774 | 0.0743 | 0.0712 | 0.0738 | 0.0733 | 0.0693 |
| Entries/Exits | 0.8714 | | 1.0414 | | 0.9642 | | 1.0570 | |
| Share of entries in M/Share of entries in WR | 0.8923 | | | | 0.9708 | | | |
| Share of exits in M/Share of exits in WR | 1.0664 | | | | 1.0643 | | | |

M: Manufacturing of textiles; WR: Wholesale and retail trade of textiles.

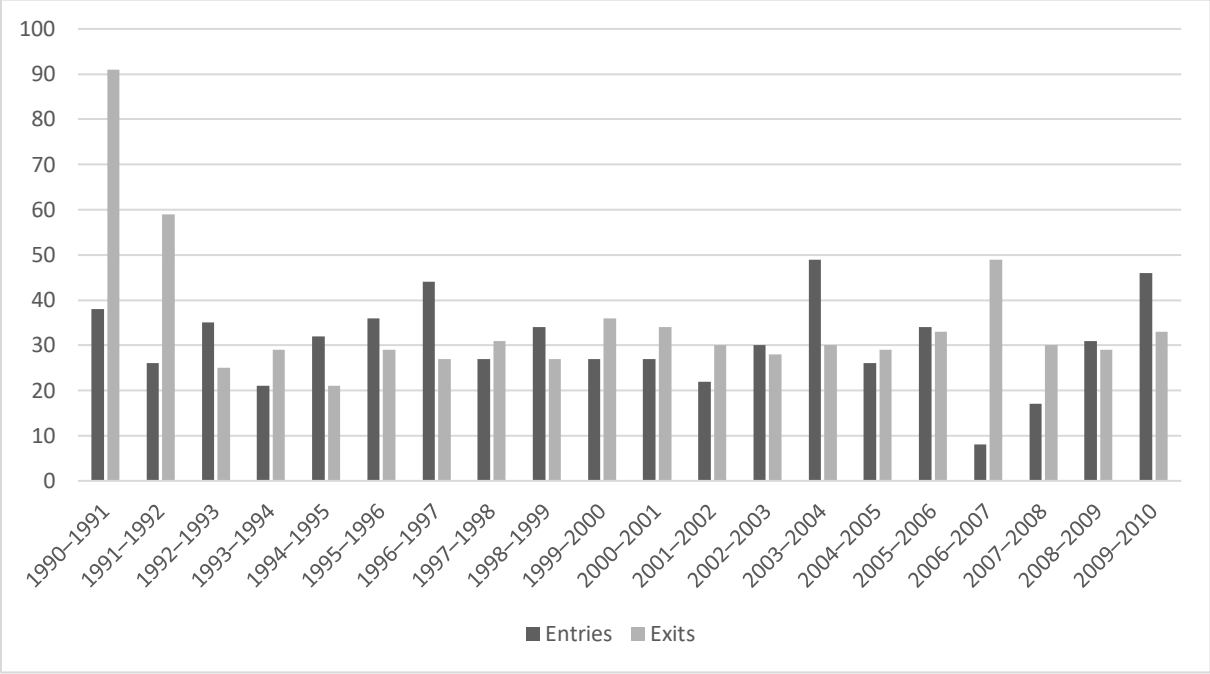



*Figure 3.6 Number of entries and exits of entrepreneurial ventures (see details in section 4) in Manufacturing of textiles in Västra Götaland 1990–2010*

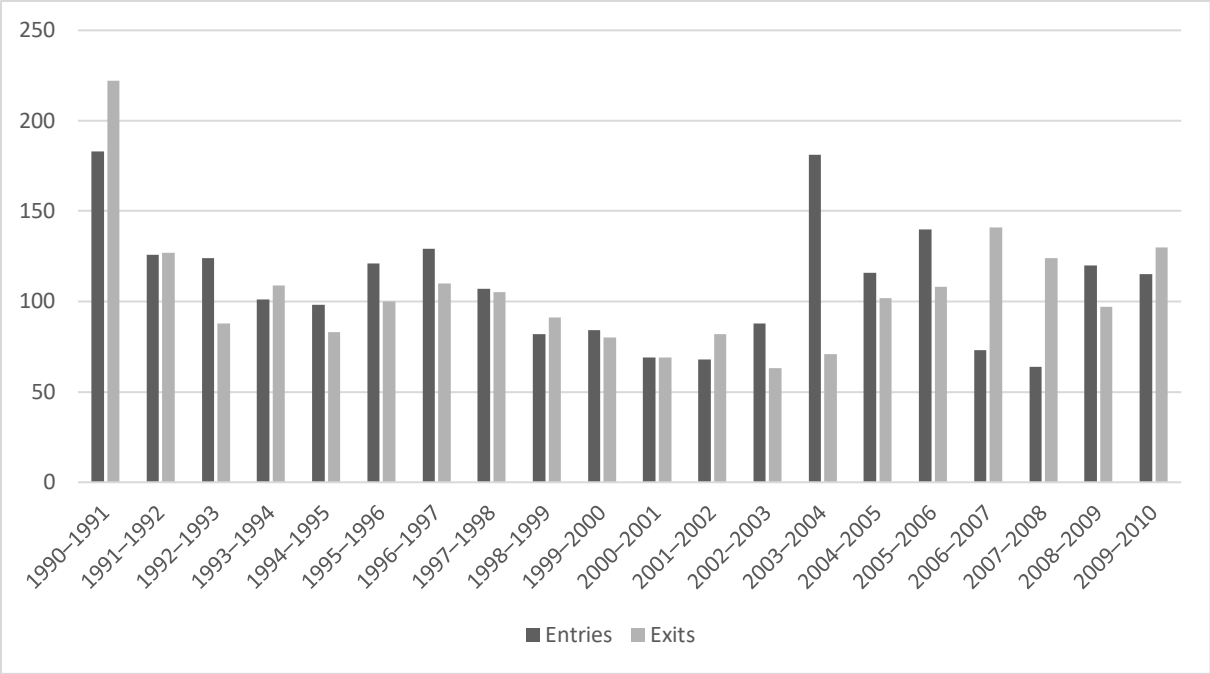



*Figure 3.7 Number of entries and exits of entrepreneurial ventures (see details in section 4) in Wholesale and retail trade of textiles in Västra Götaland 1990–2010*

A different picture is found for Manufacturing of textiles in VG, where there were fewer entries than exits during the period. The years 1990–1992, especially, which were characterized by financial crisis, were problematic in this sub-industry, as seen in Figure 3.6. It is also possible that the ending of protectionism vis-à-vis the textile industry played a role in the comparatively higher exits than entries during these years. However, Manufacturing of textiles seems to have been more affected by financial crises compared to Wholesale and retail trade of textiles in VG during the period, as the crisis in 2006–2008 also is indicated to have hit the entrepreneurial ventures harder in the former than in the latter sub-industry. Because of the high number of exits between 1990 and 1992, the number of entries per exits in Table 3.5 was lower for the period 1990–2010 than for 1995–2010. If focusing on the years 1995–2010 in order not to give too much weight to these extreme years, it can be derived from Table 3.5 that the number of entries was slightly lower than the number of exits. The 0.964 entries per exits in Manufacturing of textiles thereby stands in contrast to the 1.057 in Wholesale and retail trade of textiles in VG. The difference between these is mainly in terms of the larger share of exits in the former than in the latter. This suggests that the entrepreneurial ventures had a tougher time in Manufacturing of textiles than in Wholesale and retail trade of textiles in VG. The share of entries was also lower in Manufacturing of textiles, but still somewhat closer to the level in Wholesale and retail trade of textiles. This indicates that there were entrepreneurial opportunities present in Manufacturing of textiles during the period, which can be

expected based upon the qualitative information from secondary sources presented earlier, which indicated renewal due to the explorative and innovative and climate in this sub-industry during the period. Thus, the large-scale decline seen in terms of number of employees and number of workplaces does not tell the whole story of the development in this sub-industry. Consequently, based upon the qualitative information and quantitative data presented in this section, I classify Manufacturing of textiles in VG as subject to renewal during the period 1990–2010.

In summary, based on the qualitative information and quantitative data used in this section, I classify Manufacturing of textiles in VG as subject to a phase of renewal and Wholesale and retail trade of textiles in VG as adhering to the maturity phase of the industry life cycle during 1990–2010. Due to these different developments that have taken place in the textile industry in VG between 1990 and 2010, I distinguish between these two sub-industries throughout this PhD thesis.

# 4 Data and methods

This section describes the data and methods used for the three papers included in this thesis (see Table 4.1 for an overview). Although the different papers have different objectives, there are a number of things that they share in terms of research design. One such element is that they have a comparative design, where results for Manufacturing of textiles and Wholesale and retail trade of textiles in VG are analyzed and compared. Common to all three studies also is the usage of quantitative approaches and the measurement of relatedness for constructing the key variables. This section describes both issues common to the papers as well as certain issues specific to the papers. The section is divided into four parts, where the first describes the data and the second the sample and how it has been selected. The third part of the section outlines the operationalization of the main concepts and the procedures behind constructing the main measures used for the studies in the thesis. Finally, the fourth part describes the methods that have been used for the analysis. Whereas the section includes a lot of details due to the comparatively large amount work that has been devoted to data management (which I hope may be useful to those who aim to use similar data and methods), additional details are to be found in each of the papers.

## 4.1 Data

The papers in this thesis are concerned with studying micro-level mechanisms connected to individuals and firms in the textile industry in the West Swedish region Västra Götaland between 1990 and 2010.[24] For this purpose, all three studies rely on linked employee–employer data on individuals and firms in Sweden during the period.[25] This data is accessed through the GILDA-database (Geographical Individual Longitudinal Database for Analysis) at the Department of Economy and Society at the University of Gothenburg as part of the research area

[24] For Paper III, additional data for the period 2011–2014 are added.
[25] All individuals who at some time during the period were declared as working.

*Table 4.1 Overview of data and methods of the three studies*

| | Paper I | Paper II | Paper III |
|---|---|---|---|
| Research objective of the thesis | Investigate geographical and cognitive dimensions of labor mobility | Investigate how productive knowledge sourcing is influenced by the relatedness of the knowledge that is sourced through labor mobility | Investigate how the relatedness of the entrepreneur's prior industry experience influences the venture's survival |
| Unit of analysis | Labor flows of job-changing individuals | Job-changing individuals | New entrepreneurial ventures |
| Research design | Quantitative: Descriptive statistics and analysis of patterns and correlations<br><br>Comparative analysis of inflow and outflow labor of Manufacturing of textiles and Wholesale and retail trade of textiles in VG | Quantitative: Regression analysis<br><br>Comparative analysis of inflow labor to Manufacturing of textiles and Wholesale and retail trade of textiles in VG | Quantitative: Survival analysis<br><br>Comparative analysis of inflow labor to Manufacturing of textiles and Wholesale and retail trade of textiles in VG |
| Data source | The GILDA database at the Department of Economy and Society at the University of Gothenburg as part of the research area "Labor Mobility and Growth" (originating from Statistics Sweden) | | |

"Labor Mobility and Growth". The data originates from registers of Statistics Sweden. Most of the variables in this database contain data connected to the individual. A few variables that are connected to the individual also contain information on the individual's workplace that constitutes the individual's main income source. The workplace variables that have been used in this thesis[26] are establishment identifier (workplace number), organization number, industry affiliation, and geographical location. Since the data contain sensitive information, the individuals are connected to the different variables through a serial number and not the personal identification number, and are thereby de-identified. For security reasons, the establishment identifier and the organization number are also de-identified and are in the form of serial numbers (Statistics Sweden, 2012).

There have been some changes in the coding system for certain variables over the years that have required careful attention[27]. This concerns, for example, the time-series breaks in the Swedish industry classification system (SNI). During the period 1990–2010, there has been three time-series breaks in the SNI-system (SNI96 to SNI92, SNI92 to SNI02, and SNI02 to SNI07). However, data is available for either SNI92 or SNI02 for all the years between 1990–2010. Thus, only the transition between SNI92 and SNI02 was needed to be managed, since I use SNI02 as the base for the data included in the three studies. This transition was managed by using the keys by Statistics Sweden[28] and some additional treatment. Whereas most of the transitions are straightforward, as they match 1:1, some sub-industries had to be grouped in cases where they in SNI92 overlapped with more than one sub-industry in SNI02 (or the other way around). These transitions were managed at the 5-digit level, which is the most detailed level of the 1–5 levels in the system. The 3-digit level has thereafter been used for the industry affiliation throughout the papers in this thesis. After the previously mentioned treatments and the grouping of some sub-industries in the definitions of Manufacturing of textiles and Wholesale and retail trade of textiles in VG (see details in the following section), there are a total of 211 3-digt industries in the classification system.

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[26] Measured in November each year.

[27] Information for other users of this database: Cautiousness is also needed with regard to potential mismatches of the keys publicly available for managing the transitions between different versions of the variables. Such a mismatch was for example present for the educational level variable, where the publicly available key between HUtbSUN and SUN2000Niva_Old (Statistics Sweden, 2011) had to be adjusted based upon additional non-publicly available keys I specifically had to request from Statistics Sweden. Also, the geographical affiliation variable AstKommun had certain mismatches for some of the years around the time-series breaks.

[28] https://www.scb.se/dokumentation/klassifikationer-och-standarder/standard-for-svensk-naringsgrensindelning-sni/

Geographically, the center of attention of this thesis is the West Swedish region Västra Götaland (SE 232 in the EU-coding system at the NUTS 3 level). With regards to the labor mobility of the individuals in the textile industry in VG, it has therefore been distinguished between intra- (within VG) and inter-regional (to/from other regions) movements. In the database, the geographical location variable of the workplace is at the level of the municipality. Since its establishment in 1998 Västra Götaland has included 49 municipalities. Before the regional reform in 1998, these municipalities were part of the three counties Göteborgs och Bohus län, Älvsborgs län, and Skaraborgs län. All of the municipalities of these counties, except for Mullsjö and Habo (from Skaraborgs län, which ended up in Jönköpings län), were included in Västra Götaland after the consolidation.[29] In addition to the regional reform of Västra Götaland, there have during the period of the studies in this thesis been a regional reform in Skåne and few cases where municipalities have been taken over by other regions (or counties) or where municipalities have changed coding within the same regions. For reasons of consistency, geographical codes of municipalities, regions, and counties have been transformed to the latest version (2008). It shall be noted that throughout the thesis I call all regions and counties "regions".

In addition to the intra- and inter-regional distinction, other geographical units have also been included in Paper II and Paper III. For example, in Paper II, which focuses on wages, *local labor markets* have been included in the calculations of the wage variables to control for differences in different labor markets. In Paper III, where survival of entrepreneurial ventures is studied, I have controlled for the different geographical locations of the textile industry in VG distinguished in Section 3—Borås, the rest of Sjuhärad (excluding Borås), the Gothenburg-region, and the rest of VG—since these might provide specific conditions for the ventures.

## 4.2 Sample

This section describes the sample and the sampling procedures used in this thesis. It starts with the definition of Manufacturing of textiles and Wholesale and retail trade of textiles used throughout the papers. Thereafter, the individual-based samples in Papers I and II and the venture-based sample in Paper III are described.

[29] https://www.scb.se/hitta-statistik/regional-statistik-och-kartor/regionala-indelningar/lan-och-kommuner/

### 4.2.1 Defining Manufacturing of textiles and Wholesale and retail trade of textiles

In the definition of Manufacturing of textiles, 10 3-digit industries are included, which encompass the main letter group DB "Manufacture of textile and textile products" in SNI02 (Statistics Sweden, 2004). Table 4.2 below provides details on the 3- and 5-digit levels. For the definition of Wholesale and retail trade of textiles in VG, a collection of 5-digit industries is used (see details in Table 4.3). These 5-digit industries are all selected from 3-digit industries in SNI02 (Statistics Sweden, 2004) that include wholesale or retail trade of a wider range of products than textiles.

*Table 4.2 Definition of Manufacturing of textiles*

| 3-digit level | 5-digit level |
|---|---|
| 171 Preparation and spinning of textile fibers | 17110 Preparation and spinning of cotton-type fibers<br>17120 Preparation and spinning of woolen-type fibers<br>17130 Preparation and spinning of worsted-type fibers<br>17140 Preparation and spinning of flax-type fibers<br>17150 Throwing and preparation of silk including from noils and throwing and texturing of synthetic or artificial filament yarns<br>17160 Manufacture of sewing threads<br>17170 Preparation and spinning of other textile fibers |
| 172 Textile weaving | 17210 Cotton-type weaving<br>17220 Woolen-type weaving<br>17230 Worsted-type weaving<br>17240 Silk-type weaving<br>17250 Other textile weaving |
| 173 Finishing of textiles | 17300 Finishing of textiles |
| 174 Manufacture of made-up[30] textile articles, except apparel | 17401 Manufacture of curtains<br>17402 Manufacture of bed linen and other linen goods<br>17403 Manufacture of tarpaulins, tents, sails, etc. |

Table 4.2 continues on the following page.

[30] sewn

Table 4.2 continued.

| | |
|---|---|
| 175 Manufacture of other textiles | 17510 Manufacture of carpets and rugs<br>17520 Manufacture of cordage, rope, twine, and netting<br>17530 Manufacture of nonwovens and articles made from nonwovens, except apparel<br>17541 Manufacture of ribbon, trimmings, and lace<br>17549 Manufacture of various other textiles n.e.c. |
| 176 Manufacture of knitted and crocheted fabrics | 17600 Manufacture of knitted and crocheted fabrics |
| 177 Manufacture of knitted and crocheted articles | 17710 Manufacture of knitted and crocheted hosiery<br>17720 Manufacture of knitted and crocheted pullovers, cardigans and similar articles |
| 181 Manufacture of leather clothes | 18100 Manufacture of leather clothes |
| 182 Manufacture of other wearing apparel and accessories | 18210 Manufacture of workwear<br>18221 Manufacture of other outerwear for men and boys<br>18222 Manufacture of other outerwear for women and girls<br>18231 Manufacture of shirts and other underwear for men and boys<br>18232 Manufacture of blouses and shirts for women and girls<br>18233 Manufacture of girdles, brassieres, corsets, etc.<br>18234 Manufacture of other underwear for women and girls<br>18240 Manufacture of other wearing apparel and accessories n.e.c. |
| 183 Dressing and dyeing of fur; manufacture of articles of fur | 18300 Dressing and dyeing of fur; manufacture of articles of fur |

### 4.2.2 Individual-based samples in Papers I and II

Paper I is concerned with patterns of labor mobility of individuals who move between workplaces and either enter, leave, or move within the two parts of the textile industry in VG between 1990–2010. In a first step, the workforce of the textile industry in VG was identified as including those who are connected to a workplace in Manufacturing of textiles or Wholesale and retail trade of textiles in VG. In addition, to reduce noise in the data, the study, in similarity to previous labor mobility based studies (R. Eriksson et al., 2014; 2008; R. H. Eriksson, 2011), includes only individuals that are regarded as "established" in the labor market. In this study, this means that students and individuals who work less than half-time are excluded from the sample (see specific details in Section 4.3.2.1). In a last step, so-called "non-genuine" job-moves

*Table 4.3 Definition of Wholesale and retail trade of textiles*

| 3-digit level | 5-digit level |
|---|---|
| 511 Wholesale on a fee or contract basis | 51160 Agents involved in the sale of textiles, clothing, footwear and leather goods |
| 514 Wholesale of household goods | 51410 Wholesale of textiles<br>51420 Wholesale of clothing and footwear |
| 542 Other retail sale of new goods in specialized stores | 52410 Retail sale of textiles<br>52421 Retail sale of men's, women's, and children's clothing, mixed<br>52422 Retail sale of men's clothing<br>52423 Retail sale of women's clothing<br>52424 Retail sale of children's clothing<br>52425 Retail sale of furs<br>52431 Retail sale of footwear<br>52442 Retail sale of home furnishing textiles |
| 526 Retail sale not in stores | 52612 Retail sale of textiles and clothing via mail-order houses |

are excluded from the sample. Those are such that appear as job-moves based on changes in the establishment identifier, but which are in fact the result of ID changes of the workplaces (see Section 4.3.2.2 for further details).

The sample in Paper II is similar to that in Paper I. However, as Paper II is focused on individuals who enter workplaces in the textile industry in VG it only concerns inflows of labor. The same procedure as in Paper I has been used to include only individuals who are established in the labor market and to correct for "non-genuine" job-moves. In addition, to reduce the likelihood of the work rate of the individual changing due to retirement, all those in the age of retirement when they enter a new workplace are excluded from the analysis.

### 4.2.3 Venture-based sample in Paper III

This section is concerned with sample-based issues in connection to Paper III. Whereas the paper mentions these matters only briefly in the paper, this section provides a more detailed account of the sampling procedure.

To begin with, as Paper III is devoted to studying survival of entrepreneurial ventures, I have defined ventures at the level of the organization.[31] The reason for not choosing the level of the establishment is that the venture can continue its business despite closing down one or several establishments. The entrepreneurial venture can thereby survive, although an establishment may not.

Finding the sample of entrepreneurial textile ventures in VG implies that one should look at the industry, geographical and type of worker variables present in the database. However, these variables are all recorded for the individuals at the level of the establishment and not for the organization. Due to the fact that organizations can have more than one establishment, information regarding the location and industry in which the organization active in can be diverse. In addition, the establishments can also change industry code and municipality affiliation over the years. To arrive at only one industry code and municipality affiliation, I have therefore used a method that is inspired by Boschma and Wenting (2007), where the authors chose the municipality based upon the municipality where the organization had been active most of the time.

To arrive at a single SNI (industry code), I first calculated the number of employees for the different SNI codes divided by all the employees at the organization that year (thus, one quotient for each organization and industry code each year). Thereafter, I assigned the organization the SNI code that had the highest sum of the quotients over the years. In cases where there were more than one SNI with the highest quotient, I assigned the organization the SNI that was linked to the highest number of employees (of the organization) during the whole period. For cases where that number was equal for two SNIs of the same organization, and one of the codes was the code for the textile industry, I assigned the organization the textile industry code. The similar procedure was used for determining a single municipality affiliation.

It shall be noted that these adjusted industry and municipality codes are only used for identifying the *organizations* in the textile industry in VG. For the industry and municipality *background of the entrepreneur,* I use the SNI and municipality of the previous workplaces (the establishments) for the year in question.

In this study, only *new* entrepreneurial ventures are of interest. Most simply, entries are detected in the data when the organization number of the venture appears for the first time. However, because organization numbers can appear for reasons other than real entries (for example, when an incumbent firm changes ID), this study classifies

[31] In rare cases where the organization number is missing I have inserted an organization number based on information about the workplace (see Appendix II).

entries (and exits) according to the worker-flows between organizations, similar to the methodology of Statistics Sweden (J. Andersson and Arvidsson, 2013), Eriksson and Kuhn (2006), and Andersson and Klepper (2013). The worker flow method used in this thesis is described in further detail in Section 4.3.4. In Paper III, all entries that are classified as a result of ID changes or take-overs are excluded from the study since these cannot be regarded as new ventures. For Manufacturing of textiles in VG, the number of "real" entries is 495, and for Wholesale and retail trade of textiles in VG it is 1684. In this study, those new ventures that at the time of entry belonged to another organization are also sorted out in order to reduce the likelihood of such a parent organization influencing the survival of the venture (1% and 1.7% were sorted out in Manufacturing of textiles and Wholesale and retail trade of textiles respectively). Treatment of those ventures that came to be owned by another organization during their lifetime is described later in this section.

The sample was further narrowed down to those ventures within the textile industry in VG that had only one entrepreneur connected to them during the lifetime of the venture. This restriction was made in order to better isolate the effect of the entrepreneur's experiences and characteristics on the survival of the venture. If more than one entrepreneur is allowed, it is not clear whose experience and characteristics matter more. As seen in Table 4.4, the vast majority of the ventures had only one entrepreneur. Additionally 3.6%–4.7% were excluded, which during the start of the venture had entrepreneurs over the age of 65 years, to reduce the likelihood that their exits would be the result of retirement instead of actual failure. Treatment of the ventures with entrepreneurs who turned age 65 during the lifetime of the venture is described later.

*Table 4.4 Number of entrepreneurs who entered the textile industry in Västra Götaland 1995–2010*

| | Manufacturing of textiles | | | Wholesale and retail trade of textiles | | |
|---|---|---|---|---|---|---|
| Number of entrepreneurs | Freq. | Percent | Cum. | Freq. | Percent | Cum. |
| 1 | 411 | 83.88 | 83.88 | 1308 | 18.31 | 97.34 |
| 2 | 65 | 13.27 | 97.14 | 303 | 2.24 | 99.58 |
| 3 | 8 | 1.63 | 98.78 | 37 | 0.24 | 99.82 |
| 4 | 2 | 0.41 | 99.18 | 4 | 0.12 | 99.94 |
| 5 | 2 | 0.41 | 99.59 | 2 | 0.06 | 100 |
| 6 | 2 | 0.41 | 100.00 | 1 | 18.31 | 97.34 |
| Total | 490 | 100 | | 1655 | 100 | |

Additional ventures had to be excluded from the sample due to lack of information on the entrepreneur's industry affiliation the year prior to the entering event of the venture (see Table 4.5 below). After the exclusion, 240 and 792 ventures remained in Manufacturing of textiles in VG and Wholesale and retail trade of textiles in VG respectively. It shall be noted that an organization number, but no establishment identifier (EID), was present for many of the entrepreneurs in these cases. Additional data on income sources show that those entrepreneurs are ones who were unemployed, pensioners, students, and receiving income from active/passive business, whereas others have no information available for any of these variables.

*Table 4.5 Entrepreneurs in the textile industry in Västra Götaland excluded due to no prior industry affiliation*

| | Manufacturing of textiles | | Wholesale and retail trade of textiles | |
|---|---|---|---|---|
| | Freq. | Percentage | Freq. | Percentage |
| No EID | 116 | 74.36 | 348 | 76.65 |
| No organization & n.o. EID | 40 | 25.64 | 106 | 23.35 |
| | 156 | 100 | 454 | 100 |

In some cases the entrepreneurs are visible in the data and connected to the ventures (i.e., reported entrepreneurs) several years after the entries of the ventures. This is the case when there is at least one *employee* connected to the venture that has the venture for whom the venture is the main income source,[32] but where the *entrepreneur* has the venture as its main income source first after x years (see Table 4.6). A large majority of the entrepreneurs are not lagged in the data. For those ventures where the owner appears later, it is unclear whether or not the owner also was the founder and thereby can be regarded as the entrepreneur or not. To reduce the likelihood that the entrepreneur traced in the data was not the founder, I have only included in my sample ventures in which the entrepreneur first appears within the first two years of the venture (96.3% for Manufacturing of textiles and 88.4% for and Wholesale and retail trade of textiles in VG). This boils down to a final sample of 231 and 700 entrepreneurial ventures in Manufacturing of textiles and Wholesale and retail trade of textiles, respectively.

[32] Measured in November each year.

*Table 4.6 Number of years lag of the entrepreneur in the textile industry in VG*

| | Manufacturing of textiles in VG | | | Wholesale and retail trade of textiles in VG | | |
|---|---|---|---|---|---|---|
| Years lag | Freq. | Percent | Cum. | Freq. | Percent | Cum. |
| 0 | 220 | 91.67 | 91.67 | 605 | 76.39 | 76.39 |
| 1 | 5 | 2.08 | 93.75 | 60 | 7.58 | 83.96 |
| 2 | 6 | 2.5 | 96.25 | 35 | 4.42 | 88.38 |
| 3 | 2 | 0.83 | 97.08 | 18 | 2.27 | 90.66 |
| 4 | 1 | 0.42 | 97.5 | 13 | 1.64 | 92.3 |
| 5 | 2 | 0.83 | 98.33 | 9 | 1.14 | 93.43 |
| 6 | | | | 11 | 1.39 | 94.82 |
| 7 | 1 | 0.42 | 98.75 | 14 | 1.77 | 96.59 |
| 8 | | | | 7 | 0.88 | 97.47 |
| 9 | | | | 5 | 0.63 | 98.11 |
| 10 | 1 | 0.42 | 99.17 | 3 | 0.38 | 98.48 |
| 11 | 1 | 0.42 | 99.58 | 3 | 0.38 | 98.86 |
| 12 | 1 | 0.42 | 100 | 4 | 0.51 | 99.37 |
| 13 | | | | 4 | 0.51 | 99.87 |
| 14 | | | | 1 | 0.13 | 100 |
| Total | 240 | 100.0 | | 792 | 100.0 | |

Central to survival analysis, which is the focus of Paper III, is whether the subjects included in the sample fail or not. Those that do not fail are right censored, which means that they are no longer under observation. The most common type of right censoring takes place when the study period ends and those that have survived until then are left unobserved (Cleves et al., 2002). In Paper III, ventures that survive until 2014 are right censored due to the ending of the study. Among the other ventures, those that later go through an ID change or are being acquired are cases that, in the design of survival studies, need careful attention, as these cases are different from real exits. Buenstrof (2007), for example, mentions that acquisition is a sign of success of ventures in many high-tech industries, and should therefore not be seen as exits. To what extent this is the case in the textile industry in VG is unknown. However, prior studies with samples ranging over all types of industries (not only high-tech) in Denmark (T. Eriksson and Moritz Kuhn, 2006) and Sweden (M. Andersson and Klepper, 2013)—which in similarity to my study use the worker-flow method for classifying entries and exits—treat acquired and ID-changing ventures differently from real exits (or failures). Eriksson and Kuhn (2006), for example, exclude all ventures that change ID, but treat acquisitions as exits. Andersson and Klepper (2013), on the other hand, treat ID changes and acquisitions as right censored cases.

Another way to deal with cases that are not real exits is to make use of different models as a way of assessing the robustness of the results. This is what Caroll et al. (1996) did and what I do in my study. Here, I assess one set of models where acquisitions are treated as right-censored cases and another set of models where they are treated as failures. Exits through ID changes are included as right censored cases in both sets of models (see Table 4.7). See Section 4.3.4.2 for further details on how exits are classified using a worker-flow method. It was previously mentioned that those ventures that at their entry belonged to a parent organization or had entrepreneurs older than 65 years of age are excluded from the sample. However, if a venture sometime after its entry came to be owned by another organization or had an entrepreneur who passed age 65, the venture is treated as right censored when the event happens (see Table 4.7).

*Table 4.7 Number of failures and censored cases of entrepreneurial ventures in the textile industry in VG in Paper III*

| | Manufacturing of textiles in VG | | Wholesale and retail trade of textiles in VG | |
|---|---|---|---|---|
| | Freq. | % | Freq. | % |
| Failures | 141 | 61.0% | 414 | 59.1% |
| Acquisitions | 0 | 0% | 26 | 3.7% |
| Censored ID changes or unknown | 20 | 8.7% | 83 | 11.9% |
| Censored due to parent org. | 2 | 0.9% | 22 | 3.1% |
| Censored due to age | 16 | 6.9% | 30 | 4.3% |
| Censored at the end of the study | 52 | 22.5% | 125 | 17.9% |
| Total | 231 | 100% | 700 | 100% |

## 4.3 Main measures

This section outlines the main measures used in the thesis. As all papers focus on relatedness, the section begins with an explanation of this concept and how it has been operationalized in previous research (Section 4.3.1). Whereas different measures have been used to capture the concept of relatedness, this thesis focuses specifically on skill relatedness. The sub-section therefore also zooms in on this measure and describes how it is measured (Section 4.3.2). In Paper II, productive knowledge sourcing is studied. The operationalization of this concept as the change in wage of the worker is described in Section 4.3.3. Finally, the classification of entries and exits of organizations and establishments is outlined in Section 4.3.4.

### 4.3.1 Relatedness

Relatedness is a multidimensional and sometimes rather fuzzy concept that can have different meanings and is commonly used interchangeably to denote knowledge or technological relatedness (Boschma and Frenken, 2011a). Researchers have come up with different operationalizations with the aim of capturing knowledge or technological relatedness, for example, in terms of industry classifications (Frenken et al., 2007), occupations (Farjoun, 1994), education (Östbring et al., 2016), product portfolios (Neffke et al., 2011a), export and/or import data on products (Boschma et al., 2013; Hidalgo et al., 2007), patent data (Breschi et al., 2003), and labor mobility (Neffke and Henning, 2013).

The "traditional" approach to measuring relatedness is to rely on *the hierarchical structure of the Standard Industrial Classification (SIC) system*. Using that method, one regards two industries with a higher, more detailed, digit level (for example, five-digit) to be related if they share the same lower, less detailed, digit class (for example, two-digit) (Frenken et al., 2007). However, a problem with this SIC-based approach is that one relies on the hierarchical structure of the SIC system (Neffke and Henning, 2013), that is, one lets the SIC system decide what is related and what is not. The industries that share the same SIC codes are primarily put together based on their similarity of raw materials and can therefore not be seen as reflecting technological (Bryce and Winter, 2009) or knowledge relatedness (Essletzbichler, 2013). Thus, two industries that share the same lower digit level do not necessarily have to be related in terms of resources such as products, technologies, or skills, which are common objects of measurement for relatedness. Also, two industries that do not share the same lower digit level might be related in terms of the knowledge that is used in these industries. Whereas the SIC-based approaches are limited in this aspect, resource-based measures are not.

It has also been common to use approaches where relatedness is not predetermined by the hierarchical structure of the SIC codes. One such approach is to use *co-occurrence analysis*. Relatedness between two industries is then measured by assessing "whether two industries are often found together in one and the same economic entity" (Neffke et al., 2011a, p. 242) It has, for example, been measured how often different types of export products co-occur in countries (Hidalgo et al., 2007) and how often different types of products co-occur in firms (Bryce and Winter, 2009; Teece et al., 1994) or manufacturing plants (Neffke et al., 2011a). However, with regard to such types of studies, Neffke and Henning (2013, p. 301) note "a major disadvantage is that co-occurrence methods are essentially outcome-based, which means that these methods first *assume* that portfolios are coherent and then *infer* the implied relatedness from patterns of co-occurring industries". These co-occurrence

approaches thereby measure the outcome of economies of scope. Resource-based measures, on the other hand, overcome this issue, as they focus on the similarity between resources and therefore are concerned with the underlying causes of economies of scope (Neffke and Henning, 2013).

Although resource-based measures are advantageous due to the reasons previously explained, Neffke and Henning (2013, p. 301) recognize that "not all resources will be equally important in all industries" and that one therefore has to be careful what measure one uses. Patent data, for example, only apply to certain patent-intensive industries (Neffke and Henning, 2013) and resource-based measures of products will disregard service-intensive industries. Thus, certain resource-based measures give strategic relevance to the particular resources they measure and therefore suffer from bias (Essletzbichler, 2013).

In a recent approach that overcomes this bias, Neffke and Henning (2013) and Neffke et al. (2017b) measure *skill relatedness* by studying labor flows across industries. In contrast to the other resource-based measures, this measure works in all types of industries. Relatedness of knowledge or skills can be measured through labor flows (Neffke and Henning, 2013) because the knowledge and skills the employees possess are highly specific to their jobs (Becker, 1962) and the industries that they work within (Neal, 1995; Parent, 2000); they are rendered obsolete when the employees move to jobs in firms in completely different industries, but not to jobs in related industries. When individuals change jobs, they are therefore assumed to choose a job where they can use their preexisting knowledge and skills, that is, in a related area in the same or a related industry (Neffke and Henning, 2013). Due these favorable properties of labor mobility, and the fact that knowledge as embedded in the employees is said to be one of the most important resources of the firm (Grant, 1996), the studies in this thesis use the skill relatedness approach.

### 4.3.2 Measuring skill relatedness and correcting for non-genuine job-moves

Whereas the rational and underlying logic behind the skill relatedness approach was outlined in the previous section, this section describes how relatedness is measured using this approach.

#### *4.3.2.1 Measuring skill relatedness*

The basis of the skill-relatedness approach is the assertion that two industries are related if the number of job-moves (the labor flow) between them is exceptionally large compared to what might be expected. In the original approach by Neffke and Henning (2013) the expected value is based on some characteristics that are

considered to influence an individual's decisions to switch jobs, which is based on the desirability of another job and the ease of switching to that job (March and Simon, 1958). The former is operationalized as the average wage level in an industry, and the latter as the industry size and the growth of the industry. The expected value is derived from regression based upon these. The skill-relatedness value (SR value) is thereafter calculated as the observed number of job-moves ($F_{ij}$) from industry i to industry j divided by the expected value ($EF_{ij}$):

$$SR_{ij} = F_{ij}/EF_{ij}$$

The papers in this thesis use a later approach provided by Neffke et al. (2017b), which is based upon the original one. This later approach is less complicated to calculate and has been found to yield results similar to the latter. Instead of basing the expected value upon predicted values from regressions, it is obtained from the labor mobility rates (flow rates) of the industries:

$$EF_{ij} = F_{i.}F_{.j}/F_{..}$$

where $F_{i.}$ is the total number of workers that leave industry i for any other industry i, $F_{.j}$ is the total number of workers that enter industry j from any other industry, and $F_{..}$ is the total number of job-moves regardless of industry. Skill-relatedness (SR) is thereafter, as mentioned, calculated as the observed number of job-moves divided by the expected value. An SR value larger than 1 indicates that the industries are related. A value below 1, on the other hand, indicates that the industries are unrelated.

The conventional approaches (by Neffke and Henning (2013) and Neffke et al. (2017b)) use a threshold of 1 for categorizing industries into related and unrelated categories, where values above 1 indicate that the two industries in the industry pair are related. In addition to the conventional threshold, I have in this thesis used a higher threshold of 1.25. This is because I have recognized that the conventional approach has an upward bias if calculating only inter-industry moves and not intra-industry moves in the expected value. Thus, this bias can be derived to the eigenvalues of the matrices ($F_{i.}F_{.j}$) where the calculations of the expected value account for intra-industry moves, although such are excluded. Consequently, the expected value becomes lower than what it should for the inter-industry moves, which leads to a higher SR value. By using the higher skill-relatedness threshold[33] mentioned, in addition to the conventional, I thereby control for potential bias. It shall be noted that in Papers I and II, the results were similar for the conventional and the higher skill-

[33] Whereas this threshold is simply set at a higher level, I recommend future research to develop a systematic equation for excluding the bias.

relatedness thresholds. In Paper III, the results did change a little in terms of significance and strength, and the diagnostic tests indicated that the models with higher thresholds were performed slightly better.

As mentioned, using skill relatedness, one can find how related two industries are in terms of the skills and knowledge inherent in the labor mobility. However, although industry "j" might be related to industry "i", this does not necessarily mean that "i" is related to "j". Depending upon the relationship in focus, it is possible to calculate either *inflow* or *outflow* relatedness for each industry pair just by switching the "i" and "j" in the equations. In Papers I, both inflow and outflow relatedness are calculated, whereas Paper II and III specifically focus on inflow-relatedness to the textile industry. Further details on which flows are included are found in the Papers (Paper I includes different flows from those in Papers II and III).

To reduce noise in the data, not all job-moves are included. In all three papers, the calculations are restricted to individuals who are established in the labor market and who have made "genuine" job-moves (see below). In this thesis, students and individuals who work less than 50 % are regarded as non-established in the labor-market. To include all who work at least 50 %, a "lowest wage criterion" has been used. For this, I compared wage statistics between the private sector (Statistics Sweden, 1991) and public sector (Statistics Sweden, 1993) in Sweden[34] provided by Statistics Sweden: the lowest full-time wage was found in the public sector, which was 7,000 SEK/month in 1992. In terms of half-time work, the yearly salary in 1992's monetary value would then yield 42,000 SEK/year. This "lowest wage criterion" is further adjusted to the monetary values[35] for the years 1990–2010.

Using the skill-relatedness method, Neffke and Henning (2013) leave out individuals who are in management positions and those who are the least paid. Usually, individuals are expected to switch jobs between industries that have related skills. However, the least paid and those in management positions are considered to not adhere to this to the same extent and instead are affected by other factors. For the least paid, their skills are not thought to be rendered obsolete when they switch jobs because they are considered to have skills that are less critical to the operation in the industry. As Neffke and Henning (2013, p.304) put it: "Because an industry will typically provide the greatest rewards to the skills that are most critical to its operations, an individual's wage provides a rough indication of the importance of his

[34] In the textile industry (which is known for low wages).
[35] Using SCB's currency calculator for monetary value: http://www.sverigeisiffror.scb.se/hitta-statistik/sverige-i-siffror/prisomraknaren/

or her skills". The authors also leave out those in management positions as they may have skills that are not industry specific, but rather could be used in many industries. However, as Renski (2013, p. 30) states, "limiting the analysis risks over-emphasizing traits that may be shared by only a relatively few workers and precludes a comprehensive investigation into which industries draw from a more specialized or diverse pool of workers". To test whether it was important to leave these groups out, Renski (2013) compared results in his study with and without excluding the two groups and only found minor differences. For this reason, and also to avoid over-emphasizing specific traits of the workforce, I have chosen to not exclude the least paid (only those with a wage that indicates below half-time work as mentioned above) and those in management positions.

#### *4.3.2.2 Correcting for non-genuine job-moves*

Simply calculating the number of individuals switch jobs between industries from year to year is not enough when measuring skill-relatedness. For reasons explained below, not all job-moves are true (or "genuine") job-moves. This study therefore uses a method similar to Neffke et al. (2017b) for correcting for "non-genuine" job-moves which is based upon the work by Benedetto et al. (Benedetto et al., 2007) and Hethey-Maier and Schmieder (2013).

A job move is defined as taking place when an individual leaves one establishment for another. This can be identified in the data as a change in the EID of an individual's workplace. However, the EID of an individual's workplace can change for reasons other than a "genuine" change of the individual's workplace. In the case of ownership changes, for example, when an organization is sold to another one, the former receives the latter's EID (Hethey-Maier and Schmieder, 2013). Sometimes organizations also restructure and change legal form for accounting convenience and to avoid administrative complications. In these circumstances, the organizations change their identifiers. When analyzing data for job-moves, this appears as a large number of job-moves from one organization to another one from one year to the next, although the workforce remains at the same location and continues their operations as usual (Benedetto et al., 2007).

In the case when an establishment has changed EID but where "a large part of workers have been employed together in the previous year", the establishment is regarded as continuing (Hethey-Maier and Schmieder, 2013, p. 6). Different studies use different thresholds for what is considered "a large part of workers", usually between 30%–80%. As a middle course, the papers in this thesis uses 50% as a threshold for when the job-moves in question are regarded as non-genuine, which is also in accordance with the FAD method by Statistics Sweden (J. Andersson and Arvidsson, 2013) (see

more details on the FAD method in Section 4.3.4). The rest of the method for identifying non-genuine job-moves in the three papers in this thesis follows Neffke et al.'s (2017b) procedure: For small firms with below 5 employees, all must have changed jobs to/from the same other establishment to be regarded as non-genuine (with the exception of single-worker job-moves, which all are regarded as genuine). In addition, all moves in flows of 100 moves or more from the same establishment to the same other establishment, are also regarded as non-genuine.

### 4.3.3 Operationalization of productive knowledge sourcing

Productive knowledge sourcing is the focus in Paper II. As mentioned in Section 2, bringing in new employees is one of the main mechanisms through which firms source new knowledge. As such, knowledge sourcing is here studied in terms of labor mobility. The operationalization of productive knowledge sourcing used in this study is based upon the work by Holm et al. (2017), who used the change in (relative) wage of the worker to study reallocation/destruction of workers' skills. In similarity to Holm et al. (2017), it is here argued that the change in wage reflects the employer's valuation of the new employee's knowledge. In the study by Holm et al., a wage increase meant better reallocation of the worker's skills. Since the wage level can also be seen as an indication of the worker's productivity[36] (Hellerstein et al., 1999), I use the change in wage as an operationalization of productive knowledge sourcing of labor. The higher the change in wage of the worker, the more valuable is the knowledge of the worker to the employer likely to be, and the more productive can the knowledge sourcing be regarded. In order to reduce the likelihood that the worker's change in wage simply is a result of factors other than the valuation of the worker's knowledge, the change in *relative* wage[37] is calculated in line with Holm et al. (2012) and Eriksson et al. (2016). Here, the relative wage is obtained from the fitted values from regressions based upon the wage (dependent variable), age, gender, educational level, sector, and local labor market. As a test of robustness, an alternative dependent variable that also captures the concept of productive knowledge sourcing was constructed and found to yield similar results. This alternative variable is based on the worker's wage in relation to the average at the new workplace.

[36] It shall be noted that women in general receive lower wages than men for the same level of productivity (Hellerstein et al., 1999).

[37] The relative wage is obtained from the fitted values from regressions based upon the wage (dependent variable), age, gender, educational level, sector, and local labor market.

### 4.3.4 Classifying entries and exits

As Paper III focuses on survival of new entrepreneurial ventures, detecting entries and exits of ventures is a prime concern in the paper. Entries of organizations are also of interest in Paper II, where this has been included as a control variable, since switching jobs to new firms can negatively impact the individual's change in wage because those firms often cannot afford to pay the same wages as incumbents (Nyström and Zhetibaeva Elvung, 2015). In the GILDA database, entries and exits of organizations can be traced in the database by studying the first and last occurrence of the organization number. However, some of these first and last occurrences are spurious due to the fact that organizations can happen to change their organizational numbers in cases when they change owner or legal form, or when they restructure. Changes of organizational number in databases may also be due to coding errors. Such ID changes can be identified by studying the flow of workers between organizations in two consecutive years (i.e., the number of workers who leave the organizations for other organizations). Studying worker flows, it is also possible to identify entrants that are spin-offs and exits that are due to mergers/takeovers (Benedetto et al., 2007). For the purpose of mapping firm and establishment-based changes, Statistics Sweden has developed a worker-flow approach (the FAD method) (see J.Andersson and Arvidsson (2013) for details), which also has been used in research with aims and data related to Paper III in this thesis (see Eriksson and Kuhn (2006) and Andersson and Klepper (2013)). The method I have used for classifying organizations is similar to this method and is outlined below.

In addition to classifying entries and exits of organizations, I have also classified exits of establishments to construct a control variable used in Papers II and III. This establishment-exit variable is included to control for consequences of involuntary moves (M. Andersson and Klepper, 2013; T. Eriksson and Moritz Kuhn, 2006; Nyström and Zhetibaeva Elvung, 2015) that are likely to happen when individuals are forced to find a new job due to the closure of their workplace. Whereas the classification of entries and exits outlined below concerns organizations, the procedure for classifying entries and exits of establishments is built upon the FAD method of establishment classification (see J. Andersson and Arvidsson (2013) for details on the FAD method), which is similar to the classification of organizations below.

#### *4.3.4.1 Entries*

Basing the procedure upon the FAD method (J. Andersson and Arvidsson, 2013), I classify the entrants according to the largest clustered inflow of employees to the entrant and the clustered outflow of the successor firm. I call all entrants with over two employees "new" (codes 10–16 in Table 4.8) if they are not subject to ID changes.

An ID change is here defined as having occurred when the largest clustered inflow to an entrant that represents at least 50% of the workers at the entrant year 2 (Quotient B) comes from the same predecessor firm, where the same workers (the entrant's largest clustered inflow = the predecessor's clustered outflow) represent at least 50% of the workers at the predecessor firm year 1 (Quotient A).

> Quotient A = (Clustered outflow to the entrant)/(Number of workers at the predecessor year 1)
>
> Quotient B = (Largest clustered inflow to the entrant)/(Number of workers at the entrant year 2)

*Table 4.8 Classification of entries with >2 employees*

| Code | Quotient A | Quotient B | Predecessor | Description |
|---|---|---|---|---|
| 10 | - | <0.5 | No predecessor | New |
| 11 | <0.5 | <0.5 | Continues | New |
| 12 | <0.5 | <0.5 | Exits | New |
| 13 | ≥0.5 | <0.5 | Continues | New, takeover/unclear |
| 14 | ≥0.5 | <0.5 | Exits | New, takeover/unclear |
| 15 | <0.5 | ≥0.5 | Continues | New, spinoff pulled |
| 16 | <0.5 | ≥0.5 | Exits | New, spinoff pushed |
| 17 | ≥0.5 | ≥0.5 | Continues | ID change/unclear |
| 18 | ≥0.5 | ≥0.5 | Exits | ID change |

For *micro combinations* (Table 4.9) where the number of workers at either the predecessor or the entrant is 1 or 2, an entrant is classified as being subject to ID change if 1 or 2 workers either came from or went to the same firm and at least one of the other two criteria is fulfilled, that is:

- the workers worked at the same workplace both years (where the workplace was the only workplace of the firm), or
- the exact same employees worked together both years (where the largest clustered inflow to the entrant = the clustered outflow from the predecessor = the total number of workers in the entrant year 2 = the total number of workers in the predecessor year 1)

These entrants, which due to the ID-changing event are continuing firms, are omitted from my sample classified with code 21* and 22*. Other entrants with 1 or 2 employees are classified as "new small firms" if any of the workers were employed

previously. If none of the employees were employed previously, they are categorized as "new" (10). The entrants in the micro combinations that have more than 2 employees and are not classified as being subject to ID changes are classified according to the scheme in Table 4.8 (10–16). In cases where more than one code can occur for the same firm, the highest number of the code is assigned the highest priority.

*Table 4.9 Classification of entries in micro-combinations*

| Code | Predecessor | Description |
|---|---|---|
| 10 | No predecessor | New |
| 19 | Continues | New firm (small) |
| 20 | Exits | New firm (small) |
| 21* | Continues | ID change/unclear (small) |
| 22* | Exits | ID change (small) |

#### *4.3.4.2 Exits*

The classification of exits follows the same logic as the classification of the entrants. The exits are classified according to the largest clustered outflow of employees from the exiting firm and the clustered inflow to the successor firm. I call all entrants with over two employees "exits" (codes 10–16 in Table 4.10) if they are not subject to ID changes. An ID change is defined to have occurred when the exiting firm's largest clustered outflow to a successor that represents at least 50% of the workers at the exiting firm year 1 (Quotient A) go to the same successor firm, where the same workers (the exiting firm's largest clustered outflow=the successor's clustered inflow) represent at least 50% of the workers at the successor firm year 2 (Quotient B).

> Quotient A = (Largest clustered outflow from the exiting firm)/(Number of workers at the exiting firm year 1)
>
> Quotient B = (Clustered inflow to successor)/(Number of workers at the successor year 2)

The classification of ID changing exiting firms in *micro combinations* (21*and 22*, Table 4.11) (see definition and description above) also follow the same logic as has been described above for the entrants. These firms are sorted out from my sample, since their operations/businesses are continuing rather than exiting. The other exiting firms with 1 or 2 employees are classified as "small exiting firms" if any of the workers went to a successor (Table 4.11). If none of the employees were employed at

*Table 4.10 Classification of exits with >2 employees*

| Code | Quotient A | Quotient B | Successor | Description |
|---|---|---|---|---|
| 10 | - | <0.5 | No successor | Exit |
| 11 | <0.5 | <0.5 | Continues | Exit |
| 12 | <0.5 | <0.5 | Enters | Exit |
| 13 | <0.5 | ≥0.5 | Continues | Exit, unclear |
| 14 | <0.5 | ≥0.5 | Enters | Exit resulting in spinoff |
| 15 | ≥0.5 | <0.5 | Continues | Exit/takeover/acquisition |
| 16 | ≥0.5 | <0.5 | Enters | Exit/takeover/acquisition |
| 17 | ≥0.5 | ≥0.5 | Continues | ID-change/unclear |
| 18 | ≥0.5 | ≥0.5 | Enters | ID-change |

a successor firm, they are categorized as "exits" (10). It should further be noted that the exiting firms in the micro combinations that have more than 2 employees and are not classified as being subject to ID changes are classified according to the scheme in Table 4.10 (10–16). As for the classification of the entries, the exits are assigned the highest code if more than one code occurs for one firm.

*Table 4.11 Classification of exits in micro-combinations*

| Code | Successor | Description |
|---|---|---|
| 10 | No successor | Exit |
| 19 | Continues | Exiting firm (small) |
| 20 | Enters | Exiting firm (small) |
| 21* | Continues | ID change/unclear (small) |
| 22* | Enters | ID change (small) |

## 4.4 Methods for analysis

The methods used for the analysis are presented in this section. As mentioned earlier, the papers share some methodological characteristics. They all are concerned with the comparison of Manufacturing of textiles and Wholesale and retail trade of textiles in VG. For this, the statistics and models in the papers are made separately for the two sub-industries, which thereafter are analyzed and compared. The three papers also

rely on quantitative methods for analysis. The following sections provide an overview of these methods for each of the papers.

### 4.4.1 Paper I

Paper I investigates geographical and cognitive dimensions of inflow and outflow labor mobility in Manufacturing and Wholesale and retail trade of textiles in VG. The analysis focuses upon the extent to which the observed differences between the two sub-industries are a result of the industry life-cycle they were subject to. For this purpose, the study uses descriptive statistics and concerns analysis of patterns and correlations. The geographical dimension is studied by detecting how workers are move geographically when they change jobs. It is particularly distinguished between intra- and inter-regional mobility in order to find out how regionally attached[38] the labor mobility of the textile industry in VG is. The cognitive dimension of the labor mobility in the textile industry in VG is studied by using the skill relatedness method outlined in Section 4.3.2. To investigate to what extent cognitive proximity is manifested in inter-industry labor mobility of the textile industry in VG, the intra- and inter-regional labor mobility patterns are compared in terms of whether the same types of sub-industries are related (i.e., more labor mobility than might be expected) at both geographical distances. Correlation is also used for this purpose, in similarity to Neffke et al. (2017b). Because differences in labor mobility patterns, in addition to the industry life-cycle, also might be a result of differences in demographic composition, data on the age, gender, and educational level of the workers are integrated and analyzed.

### 4.4.2 Paper II

The aim of Paper II is to investigate the role that relatedness and related industries play for productive knowledge sourcing, in terms of labor mobility, in the textile industry in VG. The paper thereby addresses the second objective of this thesis: to investigate how productive knowledge sourcing is influenced by the relatedness of the knowledge that is sourced through labor mobility in the textile industry in VG. Paper II specifically focuses on relatedness of knowledge in terms of the worker's prior industry experience. As explained in Section 4.3.3, productive knowledge sourcing is operationalized by the worker's change in wage, which is the dependent variable in this study. Following Eriksson et al. (R. H. Eriksson et al., 2016), who made a similar study with the worker's change in wage as a dependent variable, this study

[38] It shall be noted that geographical attachment here includes both geographical and other relational factors.

uses multivariate regression analysis. More specifically, this study uses robust multivariate regression models.[39] The reason for choosing this is because the data has outliers, which the commonly used ordinary least square (OLS) regression is sensitive to. Robust regression, on the other hand deals with this issue by down-weighting influential outliers (Hamilton, 1991) and excluding large outliers[39].

Different models are used to study how the level of relatedness of the worker's industry experience is likely to influence the his/her change in wage, where the relatedness variable is constructed differently. This is in order to gain a more nuanced picture of how relatedness influences the change in wage. Yet another set of models serve as robustness tests. Those models concern a different definition of the level of relatedness, a different functional form of the dependent variable, and an alternative dependent variable. With regard to the comparison of Manufacturing of textiles and Wholesale and retail trade of textiles, two separate sets of regressions are made for these, based upon which the results are compared and analyzed.

### 4.4.3 Paper III

Paper III studies how the level of relatedness of the entrepreneur's prior industry experience influences the venture's survival chances in the textile industry in VG. For this purpose, the paper uses survival analysis based on calculations of Cox's proportional hazard ratios, which is a commonly used method for survival analysis within the industrial organization field (Manjón-Antolín and Arauzo-Carod, 2008). The advantage of this method in comparison to linear regression is that it takes into account that the failure time is not normally distributed. In comparison to parametric models, the Cox model can be less efficient due to the fact that the baseline hazard is left non-parameterized, i.e. that the failure time distribution is left unspecified. One of the inefficiencies of the Cox model with this regard is that time is only considered for ordering the observations. However, an advantage of the Cox model is that its semi-parametric feature avoids bias in the survival analysis that can arise from misspecification of the failure-time distribution, which is a common problem in parametric hazard models. The non-parameterization of the baseline hazard can also make the Cox model less efficient than correctly specified parametric models in that it is only concerned with comparing subjects that fail with those that do not fail at the same time of analysis instead of taking into account all the data from the previous time-period during w2hich it was under observation (Cleves et al., 2002). However, I do not regard this issue to be a problem in Paper III when using Cox due to the fact

[39] For details see: Stata.com. rreg — Robust regression. Available at: https://www.stata.com/manuals13/rrreg.pdf [Accessed 2018-04-16]

that most of the variables I use either are time invariant (with the focus on the experience of the entrepreneur prior to the entry) or are constantly increasing (such as age).

With regard to the time frame of the study, ventures that entered sometime between 1995 and 2010 are included. The study period for survival is, however, extended to 2014, since data on this is available for those extra years.[40] Data on the entrepreneur's prior experience is gathered from the years prior to the entering event of the venture. As knowledge can rest in individuals for several years, different models are included to account for this. These different models are based on background scanning of 1, 3, and 5 years, respectively. Different types of models have also been included, where the level of relatedness is defined differently. It has previously been explained that it is not clear whether acquisitions should be regarded as failures or not. In addition to the results presented for the models where acquisitions are treated as censored cases, models have also been run where acquisitions are treated as failures, in order to test robustness. Just as in Paper II, Manufacturing of textiles and Wholesale and retail trade of textiles are treated in separate models, which are compared and analyzed to study differences between the two sub-industries.

[40] For the years 2011–2014, it was not possible to use the industry affiliation variable since it was recorded according to the SNI07 industry classification system for that period. Whereas the time-series break between SNI92 and SNI02 was possible to manage, the time-series break between SNI02 and SNI07 was too severe to be managed successfully.

# 5 Summary of the papers

This section briefly summarizes the papers in this thesis.

## 5.1 Paper I

Title: Geographical and cognitive labor mobility patterns: A comparative analysis of two parts of the West Swedish textile industry

This paper aims to investigate geographical and cognitive dimensions of industry labor mobility in the textile industry in Västra Götaland (VG). Labor mobility is one of the most important mechanisms through which firms assimilate new knowledge, learn, and develop. Despite this fact, little is known about patterns and structures of inter-industry labor mobility.[41] The purpose of Paper I is to contribute more knowledge about the geographical and cognitive dimensions of inter-industry labor mobility, as these are emphasized in the literature to be especially influential for knowledge transfer. More specifically, the geographical dimension is studied by focusing on regional attachment in terms of the extent of intra- and inter-regional labor mobility. The cognitive dimension focuses on cognitive proximity and the extent to which labor mobility exhibits homo-/heterogeneity in this aspect. From this, it is determined how well labor mobility follows cognitive patterns. The method for this builds upon previous research by using a labor mobility approach for measuring cognitive proximity (captured by relatedness) and correlation analysis to measuring homo-/heterogeneity (or consistency) (see Neffke et al., 2017b). Paper I further incorporates an industry life-cycle perspective and argues that labor mobility is likely to exhibit different patterns in the different phases of the industry life cycle.

The paper finds a dominance of intra-regional labor mobility in the textile industry in VG, which indicates that the industry is highly regionally attached through its labor mobility. In addition, the textile industry in VG seems to exhibit a consistency in cognitive patterns, which indicates that labor mobility is not only a result of co-location factors. It is, however, also found that the two sub-industries, Manufacturing

[41] See Neffke et al. (2017).

of textiles and Wholesale and retail trade of textiles in VG, differ with regard to the geographical and cognitive dimensions. Manufacturing of textiles in VG is more geographically attached than is Wholesale and retail trade of textiles. This might be due to differences connected to their different industry life-cycle phases. However, observed differences in demographics are also likely to be part of the explanation, which is discussed in the paper in connection to "location-specific insider advantages"[42]. The results, moreover, indicate that Manufacturing of textiles in VG is less consistent in terms of cognitive proximity than Wholesale and retail trade of textiles. Further research is suggested to resolve to what extent this can be attributed to differences in industry life-cycle phases.

## 5.2 Paper II

Title: Productive knowledge sourcing in the West Swedish textile industry: The role of labor from related industries

The aim of Paper II is to investigate the role that relatedness and related industries play in productive knowledge sourcing, in terms of labor mobility, in the textile industry in Västra Götaland (VG). Labor mobility is known to be one of the main knowledge transfer mechanism through which new knowledge can be assimilated by firms and stimulate learning and development, which is essential for firms to successfully respond to the environment. Because knowledge sourcing, in terms of labor, is an important mechanism for firms, and consequently, for industry and economic development, studying how productively firms can make use of this type of knowledge sourced from related industries contributes to the understanding of how related industries—and related variety of industries in regions—influence economic development. Whereas macro level studies on the role of relatedness and related variety are limited in that they study indirect relationships to economic development, this paper contributes with a more direct link between the role of relatedness and related industries and economic development by studying a mechanism through which this association is likely to originate. The paper also contributes to the research field with an industry life-cycle perspective, which has received little empirical investigation in connection to the role of related variety and relatedness.

The paper uses regression analysis to investigate how productive knowledge sourcing is influenced by the level of relatedness of the knowledge that is sourced. Relatedness is measured using a recently developed labor mobility approach (Neffke et al., 2017b).

[42] See Fischer and Malmberg (2001).

Productive knowledge sourcing is operationalized as the change in wage of the worker, as this mirrors how much the new employer values the knowledge of the worker, and consequently, how *productive* the knowledge sourcing is. Using the change in wage as a measure of employers' valuation of workers' knowledge builds upon previous research where reallocation and destruction of skills have been studied for workers who left declining industries (R. H. Eriksson et al., 2016; Holm et al., 2017). Whereas these studies focused on workers who left these industries, this paper is devoted towards the entering workers who bring new knowledge into the industry. The context for this study is the textile industry in VG, where it is distinguished between Manufacturing of textiles and Wholesale and retail trade of textiles, as these two sub-industries have been subject to different development paths and adhere to different phases in the life cycle.

The results indicate that other industries that are more related are better sources of knowledge than less related industries are, which partly confirms the related variety and relatedness thesis. It is furthermore indicated that knowledge sourcing from related industries is as productive as from the same sub-industry in Manufacturing of textiles in VG. In Wholesale and retail trade of textiles in VG, on the other hand, knowledge seems far more productive when sourced from the same sub-industry than from other industries, including related industries. This difference in relative productivity of knowledge sourcing from the same sub-industry is interpreted to be a result of the different phases in the industry life cycle that the two sub-industries were subject to during the period. More specifically, I interpret that Wholesale and retail trade of textiles in VG benefited more from knowledge sourced from the same sub-industry because it was subject to maturity. This is because maturity is characterized by specialization and exploitation, where industry-specific knowledge from the same sub-industry consequently would be in greater demand. Compared to Wholesale and retail trade of textiles, Manufacturing of textiles in VG is interpreted to have benefitted comparatively less from industry-specific knowledge from the same sub-industry because it was subject to renewal. It is explained in the paper that this is because renewal is a phase that can be seen in light of creative destruction whereby the industry-specific knowledge from the same sub-industry to a larger extent becomes redundant, and new (related) knowledge is important for the explorative activities that characterize this phase.

## 5.3 Paper III

Title: The influence of the entrepreneur's prior industry experience on the venture's survival: A comparative analysis on the role of relatedness in two parts of the West Swedish textile industry

Paper III investigates how related industry experience of the entrepreneur influences the venture's survival in the textile industry in Västra Götaland (VG). Like Paper II, this paper contributes to the research on related variety and relatedness with a micro-level study on an important mechanism behind economic development. The paper also contributes to the literature on entrepreneurship by providing more knowledge about the role of related industry experience. It has been acknowledged in the literature on entrepreneurship that entrepreneurs are guided by their prior knowledge. In terms of the role of prior industry experience for the venture's survival, there is a fair number of studies that provide evidence that experience from the same industry positively influences survival. However, little is known about how survival of ventures is influenced by entrepreneurs with prior experience from related industries.

Survival analyses using Cox proportional hazard ratios are conducted in which the entrepreneur's prior industry experience is measured in terms of the prior industry's relatedness to the sub-textile industry the entrepreneur enters. Relatedness is, as in Paper II, measured using a labor mobility approach (Neffke et al., 2017b). The textile industry in VG, which is the context for the study, is, as in Papers I and II, divided into Manufacturing of textiles and Wholesale and retail trade of textiles according to the different phases they adhere to in the industry life cycle.

Investigating the relative importance of unrelated, related, and same sub-industry experience reveals interesting differences between the two parts (sub-industries) of the textile industry, which, just as in Paper II, are interpreted to be due to the phase in the industry life cycle they adhere to. In Wholesale and retail trade of textiles in VG, the venture has significantly higher survival chances if the entrepreneur has experience from the same sub-industry as compared to having experience from related industries, and especially in comparison to having experience from unrelated industries. This is interpreted as being due to the maturity phase that Wholesale and retail trade of textiles in VG adheres to, which is characterized by specialization and exploitation, suggesting that experience from the same sub-industry is required to successfully compete in the sub-industry.

In Manufacturing of textiles in VG—which was subject to growth during the period—the survival chances of the venture were significantly higher if the entrepreneur had experience from a related industry as compared to experience from unrelated industries and especially in comparison to experience from the same sub-industry. In line with the interpretations in Paper II, related experience proved more viable than same sub-industry knowledge in Manufacturing of textiles in VG most likely because of the characteristics of the renewal phase that it was subject to. It is interpreted that in renewal, the process of creative destruction implies that ventures based upon old

(same sub-industry) knowledge and ideas to a larger extent become redundant, whereas ventures based upon new knowledge and ideas have an advantage, as the firms in the (sub-)industry need to find new paths different from the old ones that have led to decline. In addition, the fact that related, compared to unrelated, industry experience significantly increased the chances for survival emphasizes the related variety and relatedness thesis: not just any new knowledge is equally conducive in renewal, but rather the type of knowledge that is related that proves to be what is most conducive in this phase.

# 6 Concluding discussion

In the context of the textile industry in the West Swedish region Västra Götaland (VG), the aim of my PhD thesis has been to contribute to the understanding about how industry dynamics are influenced by relatedness of knowledge transferred through labor mobility and entrepreneurship. Acquiring new knowledge is a prime concern for firms, enabling them to respond to and develop in an ever-changing environment. Because knowledge is embodied in individuals (Grant, 1996), firms mainly acquire new knowledge by taking on new employees through labor mobility (Simon, 1991). Labor mobility is thereby regarded as one of the main mechanisms of knowledge transfer for firms (A. Malmberg and Power, 2005; Power and Lundmark, 2004; Song et al., 2003). As this knowledge transfer mechanism largely impacts firms, understanding more about it can contribute to the knowledge about firm, industry, and economic development (Mamede, 2008).

Whereas economic geographers have long emphasized the role of geographical proximity as important for knowledge transfer, more recent research in evolutionary economic geography highlights the role of cognitive proximity (Boschma and Frenken, 2011a). In latter years, it has especially been argued that the cognitive distance should be neither too large, nor too small for ensuring efficient and useful knowledge transfer (Nooteboom, 2000). *Related* knowledge has thereby been argued to play a vital role for the development of firms, industries and the economy as a whole. In this thesis, it has also been acknowledged that the type of knowledge required by firms is likely to differ in different phases of the industry life cycle (Neffke et al., 2011b; Ter Wal and Boschma, 2011). With regard to the textile industry in VG, I have distinguished between Manufacturing of textiles and Wholesale and retail trade of textiles and classified the former as subject to renewal and the latter as subject to maturity during the period studied in this thesis. In addition to general patterns, my analysis has therefore focused on comparing differences between the two sub-industries in relation to knowledge transfer through labor mobility. The following sub-section presents my overarching findings and conclusions. Thereafter are limitations discussed and suggestions for future research provided.

## 6.1 Overarching findings

One of the objectives of my thesis was to describe the labor mobility patterns of the two parts of the textile industry in VG in terms of cognitive and geographical dimensions. For this purpose, I have focused on regional attachment and cognitive proximity of labor mobility. My research indicates that the textile industry in VG is largely regionally attached (referring to more intra- than inter-regional labor mobility) through its labor mobility, similar to results by Eriksson, Lindgren, and Malmberg (2008) and Boschma et al. (2009). However, I also found that the labor mobility patterns are not driven only by co-location factors. More specifically, the finding that the labor mobility patterns were relatively consistent intra- and inter-regionally indicates, in my interpretation, that labor mobility also is driven by cognitive proximity. This is in line with previous research on labor mobility in Germany (see Neffke et al., 2017b).

My results moreover indicate that Manufacturing of textiles and Wholesale and retail trade of textiles in VG differ with regard to regional attachment. Whereas more research needs to be done on whether and how this can be attributed to differences in industry life-cycle phases, the results indicate that the differences in demographics found in this study might be part of the explanation. This is in line with previous research by, for example, Fischer and Malmberg (2001) on why certain individuals are more reluctant to move than others. With regard to the cognitive dimension, a larger extent of heterogeneity was found for Manufacturing of textiles compared to Wholesale and retail trade of textiles in VG. Whereas this appears to be in line with industry life-cycle theories, further research is needed to verify this relationship.

My second objective in this thesis was to investigate how productive knowledge sourcing is influenced by the relatedness of knowledge (which reflects cognitive proximity of individuals) that is sourced through labor mobility in the two parts of the textile industry. Similarly, the third objective was to also investigate how relatedness of knowledge influenced performance of firms, although the focus was on survival of entrepreneurial ventures, and relatedness of knowledge was investigated in terms of the prior industry experience of the entrepreneur. Thus, these two objectives are similar in that they both concern how relatedness of knowledge of individuals influences firm performance. In addition, the results for these objectives follow a similar pattern for Manufacturing of textiles and Wholesale and retail trade of textiles in VG, which share similar conclusions.

Distinguishing between different levels of relatedness of the knowledge of the individuals, the results indicate that not just any type of knowledge brought in through labor mobility is equally conducive in the textile industry in VG. In addition,

the type of knowledge brought in by labor mobility proved differently useful in the two parts of the textile industry. Compared to knowledge from related or unrelated industries, knowledge from the same sub-industry seemed more useful in Wholesale and retail trade of textiles in VG. In contrast, in comparison to Wholesale and retail trade of textiles in VG, firms in Manufacturing of textiles in VG seemed to benefit more from related knowledge. These differences were in line with the expectations, since the different industry life-cycle phases Manufacturing of textiles and Wholesale and retail trade of textiles in VG were subject to during the period are likely to entail different knowledge requirements.

Renewal, which Manufacturing of textiles in VG was subject to, entails a "significant change of the existing trajectory of development" (Chapman et al., 2004, p. 383) and thereby requires firms to refocus on new types of activities and exploration with new related knowledge, as indicated by Menzel and Fornahl (2010) and Isaksen and Trippl (2014). In renewal, the old (sub-)industry knowledge is, in my interpretation, therefore likely to be redundant to a larger extent and in need of replacement by and recombination with new related knowledge. This most likely explains why firms in Manufacturing of textiles in VG benefited from related knowledge. By contrast, firms in Wholesale and retail trade of textiles in VG benefited more from knowledge from the same sub-industry, which I interpret to be due to the maturity phase the sub-industry adhered to. This is because firms in the maturity phase require more industry-specific knowledge since this phase implies a comparatively larger focus on specialized (Neffke et al., 2011b) and exploitative (Lumpkin and Dess, 2001) activities.

The relative usefulness of related knowledge in Manufacturing of textiles in VG, however, differed, somewhat between the different studies in this thesis. In terms of knowledge sourcing by firms, workers with related knowledge were found to be as productive for the firm as workers with knowledge from the same sub-industry. Knowledge from unrelated industries proved the least useful in this case. With regard to the prior industry experience of the entrepreneur, on the other hand, related knowledge proved the most positive for the survival of the venture—more than unrelated knowledge and even more than same sub-industry knowledge. My interpretation in this regard is that the role of relatedness of knowledge is likely to differ somewhat, depending on through whom the knowledge was internalized, and on the type of firm, the outcome studied, and the industry life-cycle phase.

In summary, the results presented in this thesis provide some new insights on industry dynamics in terms of knowledge transfer through labor mobility. Labor mobility in the textile industry in VG has been found to not only be regionally attached, but also to be attributing cognitive patterns, which is captured by relatedness of

knowledge. My results further indicate that relatedness of knowledge is influential for how productively firms can make use of the knowledge they source through labor as well as influential in terms of how the entrepreneur's experience influences the survival chances of the venture. In addition, the results indicated that the two sub-industries studied were differently influenced by the degree of the relatedness of knowledge, which is suggested to be the result of the different phases the sub-industries adhered to in the industry life cycle. The role of relatedness of knowledge also differed somewhat between the different studies, suggesting that the answer to what role relatedness of knowledge plays in the economy might depend upon the type of firm, the source of knowledge, and outcome, in addition to the industry life-cycle phase. As explained in the following sub-section, further research needs to be made also in other context to test the generalizability of the findings of this thesis.

## 6.2 Limitations and future research

With regard to the industry life-cycle perspective, a limitation of my research in this thesis is that the sub-industries have been followed over a limited period of time and it therefore not has been possible to study differences connected to industry life-cycle phases within each of the sub-industries. This makes it relevant to ask whether the differences observed might be due to other characteristics of these sub-industries. Analysis of alternative explanations for the different results of these two parts of the textile industry in VG—Manufacturing of textiles and Wholesale and retail trade of textiles—has therefore focused on whether the differences can be attributed to the different types of activities involved connected to their different sector affiliations. There are, however, both arguments and counterarguments in this regard (see further details in the papers) that warrant further research.

Although the explanations of the relative role of knowledge from related industries and the same sub-industry are in line with the life-cycle theories derived from the literature, it needs to be kept in mind that the results are limited to the two parts of the textile industry in VG. I therefore encourage future research to investigate whether these findings and explanations can be found in yet other contexts (other industries and regions) and to also explore other phases of the industry life cycle. I also see context-specific variations (Tödtling and Trippl, 2005; see for example 2004) to be likely in the role of relatedness of knowledge. Boschma (2017), for example, highlights that unrelated regional diversification also occurs, although related regional diversification predominates, and that differences might have to do with local

differences connected to institutions[43]. Thus, whereas related knowledge seems to be important in renewal and industry-specific knowledge in maturity in this particular thesis, variations could depend on context; consequently, it is advisable to make a careful context-specific analysis before generalizing policy implications, to avoid "one size fits all" policy implementation (Tödtling and Trippl, 2005). Future research should therefore preferably investigate how other factors, such as institutions, are likely to influence the role of relatedness of knowledge in connection to different life-cycle phases.

In addition to investigating how context-specific factors may influence the role of relatedness of knowledge in different industry life-cycle phases, I also encourage future research to delve more deeply into differences between the role of relatedness of knowledge for different knowledge transfer mechanisms. The results from my research indicate that there may be a difference in this regard. More specifically, in Manufacturing of textiles in VG the relative importance of knowledge from the same sub-industry as compared to knowledge from related industries was lower in terms of the entrepreneur's prior industry experience for the venture's survival than it was for productive knowledge sourcing through labor mobility by firms in general. As I previously mentioned, the importance of different types of knowledge might thereby differ somewhat, depending on through whom the knowledge was internalized, and on the type of firm, the outcome studied, and the industry life-cycle phase. I find it promising for future research to explore such differences further since that can give a more nuanced picture of how relatedness of knowledge influences industry dynamics. It is therefore relevant for future research also to investigate the role of relatedness for yet other knowledge transfer mechanisms (for example various forms of collaboration with other actors) and for other types of outcomes, in addition to different contexts. Based on the findings of my research, I do, however, propose that future research should take industry life cycles into account when investigating the role of relatedness of knowledge for knowledge transfer mechanisms of firm, industries, and the economy at large.

Another limitation of the research in this thesis is that it is concerned with relatively short-term influences of relatedness of knowledge for industry dynamics. Nevertheless, what is advantageous in the short term might not have to be so in the long term. For example, the context of Wholesale and retail trade of textiles in VG indicates that same sub-industry knowledge was the most beneficial, which highlights that the sub-industry benefitted from specialization. However, at the level of the

[43] For example "hard" institutions such as regulations of capital, labor, and product markets as well as "soft" institutions connected to norms, values, and so forth.

region, industry set-ups that are too specialized and narrowly focused have been argued to be particularly vulnerable to changes (or shocks) (McCann and Ortega-Argilés, 2013). It has also been indicated that resilience might be increased by promoting related variety (and possibly also unrelated variety) in the industry set-up (although more research is needed to confirm this) (Boschma, 2015). This is why the smart-specialization strategy in the EU has been argued to be in need of an integration with the related variety concept to decrease vulnerability and promote growth (McCann and Ortega-Argilés, 2013), which would secure stable and positive long-term development. However, would this reasoning be relevant for industries? Is it advantageous in the long run to partly promote related (or unrelated) knowledge transfer in industries in maturity even though the industries in the short term might benefit more from industry-specific knowledge? These questions warrant further research. Nevertheless, mature industries have been found to benefit from exploring new sub-markets, as noticed by Klepper (2016).

A similar topic that concerns how to promote resilience, but at the level of the organization, is ambidexterity. This concept is established in the management literature at the level of the organization (for example, Bower and Christensen, 1995, Christensen, 1997, and Tushman and O'Reilly III 1996) but has recently also been applied to clusters (see, for example, Kauppila, 2007; Ferrary, 2011; Bocquet and Mothe, 2017; and Wolf et al. 2017). The concept emphasizes simultaneous engagement in exploration (of new knowledge and new combinations) and exploitation (of existing competencies) to be able to manage both long-term and short-term competitiveness. The central argument in this literature is that today's "core capabilities" can become tomorrow's "core rigidities" (using Leonard-Barton's, 1992, terminology) and result in failure when facing radical change and disruptive technologies if not investing in exploration at the same time as exploiting today's opportunities with existing competencies (O'Reilly and Tushman, 2008). As ambidexterity refers to management of exploration and exploitation (which is close to the terminology of variety and specialization) simultaneously, my interpretation is that the ideas behind this concept could potentially be useful to integrate into evolutionary economic geography and industry policy. This might be useful to look further into, concerning how to simultaneously promote long- and short-term success in managing both specialization and diversity (the latter in terms of related or unrelated knowledge, depending on context) in mature industries.

In summary, based upon my research, I encourage future research to take industry life cycles into account when investigating the role of relatedness of knowledge for development of firms, industries, and the economy at large. My research also indicates that the role of relatedness of knowledge can differ depending upon the source of knowledge, and on the type of firm and the outcome studied. I therefore suggest that

future research should distinguish between different sources, firms, and outcomes. More knowledge is also needed with regards to context-specific variations (other industries and regions) and short- and long-term effects.

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# Appendices

## Appendix I: Definitions of textiles

Dictionary.com[44] provides the following definition of textile: "1. any cloth or goods produced by weaving, knitting, or felting. 2. a material, as a fiber or yarn, used in or suitable for weaving: *Glass can be used as a textile*". "All textile products other than those intended for apparel, household and furnishing end-uses" have traditionally been referred to as *industrial textiles* (Byrne, 2000, p. 2). Today, industrial textiles are, however, often referred to when talking about "textiles products used in the course of manufacturing operations (such as filters, machine clothing, conveyor belts, abrasive substrates etc.) or which are incorporated into other industrial products (such as electrical components and cables, flexible seals and diaphragms, or acoustic and thermal insulation for domestic and industrial appliances)" (Byrne, 2000, p. 3). These are seen as a subgroup of the broader category *technical textiles*. Nevertheless, the definition for these technical textiles provided by the Textiles Institute's "Textile Terms and Definitions" is much in line with the traditional understanding of industrial textiles, where the former are defined as "textile materials and products manufactured primarily for their technical and performance properties rather than their aesthetic or decorative characteristics" (Textile Institute 1994, cited in Byrne 2000 p. 2). Byrne (2000) criticizes the definition as being too brief and imprecise. In addition, the term, technical textiles is used in different ways in different publications and among different organizations. However, Byrne (2000, p. 2) also recognizes the difficulty of construction a definition due to the rapid technological developments in the field: "In what is one of the most dynamic and broad ranging areas of modern textiles, materials, processes, products and applications are all changing too rapidly to define and document". Application areas for technical textiles are commonly listed as

- agrotech: agriculture, aquaculture, horticulture and forestry
- buildtech: building and construction
- clothtech: technical components of footwear and clothing

[44] *Definition of textile*, Available at: http://www.dictionary.com/browse/textile [Accessed 2018-04-16]

- geotech: geotextiles and civil engineering
- hometech: technical components of furniture, household textiles and floorcoverings
- indutech: filtration, conveying, cleaning and other industrial uses
- medtech: hygiene and medical
- mobiltech: automobiles, shipping, railways and aerospace
- oekotech: environmental protection
- packtech: packaging
- protech: personal and property protection
- sportech: sport and leisure

These areas are not used only when talking about technical textiles, but also to varying degrees for *functional textiles, engineered textiles*, and *high-tech textiles* (Byrne, 2000).

Functional textiles are textiles that offer additional functionalities. These textiles can, for example, be waterproof, windproof, thermo-regulative, breathable, stain resistant, anti-microbial, UV protective, electro conductive, electrical shielding, antistatic, skin protective, or water regulative (F. Meister, 2012, p. 3). According to Meister (2012), some of most important areas of functional textiles are industry textiles, sports/outdoor textiles, home textiles, geotextiles, medical and hygienic textiles, and protective textiles/work wear, which span many of the areas listed for technical textiles above.

Another emerging area within textiles is *smart textiles*, sometimes also referred to as intelligent textiles, electro-, or e-textiles. A distinction is often made between smart- and functional textiles, where the latter "can include traditional textile products while [the former] have intrinsic properties that are not normally associated with traditional textiles (Cherenack and van Pieterson, 2012, p. 2). Smart textiles can be defined as "textiles that are able to sense stimuli from the environment, to react to them and adapt to them by integration of functionalities in the textile structure. The stimulus and response can have an electrical, thermal, chemical, magnetic or other origin" (Van langenhove and Hertleer, 2004, p. 63). Smart textiles are often divided into passive, active, and very smart textiles depending on their level of intelligence. *Passive* smart textiles are ones that can sense the environment. They are sensors that can "transform a signal into another signal that can be read and understood by a predefined reader, … for example a real device or a person" (Van langenhove and Hertleer, 2004, p. 65). A common way of transferring these signals is by using electroconductive materials. *Active* smart textiles can not only sense the environment but also react to it by for example making things move, releasing substances, making noise, and so forth. In addition to these functions, *very* smart textiles can adapt to the environment (Van langenhove and Hertleer, 2004, p. 63).

# Appendix II: Adjustment of organization number

In a small number of cases, the organization number is missing for individuals in the database, although there sometimes is an establishment connected to them within which there are other workers who have both the establishment and organization number connected to them. Moreover, in some cases the organization number is missing for one or several years for all individuals in certain establishments although the organization number is present for most of the years. I have thereby generated a new, adjusted organization number variable, where the organization number is inserted for workplaces and individuals in those years where the number is "0" or ".". The following adjustments have been made:

- In cases where the organization number is missing for one or several individuals who work at the same workplace as another individual who has an organization number connected to him/her, all the individuals in the same workplace receive the same organization number as the one that was present for that particular year.
- Where no individuals in a workplace have an organization number linked to them for one or several years – but there are other years with an associated organization number for the same workplace – the last occurring organization number has been inserted for the years without numbers.
- In cases where the organization number first occurs one or several years after the workplace first appears in the database, the organization number inserted for those first years is based upon the first occurring organization number for that workplace.