Optimal Levels of Embeddedness

The Contingent Value of Networked Collaboration

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"The Doctoral School of Economics and Management is an active national and international research environment at CBS for research degree students who deal with economics and management at business, industry and country level in a theoretical and empirical manner".

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Working on this dissertation has been a learning experience. Coming from a background in sociology, I entered the world of academia as a research assistant in the field of economic geography. Despite my lack of knowledge of this field, some themes and perspectives were familiar. These were the discussions on effects of knowledge workers, proximity, and knowledge exchange. With this point of departure I somewhat unintentionally developed ideas more and more aligned with discussions within management literature. The result is a dissertation drawing on all three research traditions in the attempt to provide explanations for costs and benefits of different types of embeddedness. I analyze embeddedness as co-location, as embeddedness in local industry network structures, and as association with foreign settings. Each paper in this dissertation ends with acknowledgement of the people who contributed to the development of that paper. But others provided assistance of a more general nature, or simply deserve general acknowledgement too.

The Danish Producers Association and the Creative Encounters research project at Copenhagen Business School supplied the necessary funding, contacts and insights into the world of creative industries. The Danish Film Institute has been a valued partner in developing the database used in chapter 3 and 4. Members of the Technology, Talent, and Tolerance research project provided data for chapter 2. I am grateful to you for that and for all I have learned from you.

During my PhD Fellowship I had the good fortune to visit the Martin Prosperity Institute at Rotman School of Management, University of Toronto. Even with the freezing temperatures of a Torontonian winter, it was an entirely enjoyable learning experience and I am grateful to the people who welcomed

me at University of Toronto and let me enter their research environment and community.

The research environment at the Department of Innovation and Organizational Economics at Copenhagen Business School has proven a excellent place to enter academia. Here, I found colleagues with a diversity of high level competences, ready to share their knowledge, interests, and time. In the final stressful stage of my fellowship, these amazing people increased their support, and I am most grateful for their engagement in my future career. Besides from all the comments on presentations and papers, and all of the enjoyable, informal lunchroom discussions, these people taught me by word and example that research is supposed to be fun. Not all of the time, maybe not even most of the time, but occasionally, it should be fun to develop and test novel ideas about the workings of the world. I thank you for that important insight, just as much as I thank you for all the comments!

Finally, I am grateful for the expert supervision I have been so fortunate to receive from my two wonderful supervisors, Mark Lorenzen and Toke Reichstein. Both taught me invaluable lessons on how to do research and how to navigate in academia. If I repeat your mistakes, it is only because you trained me too well ;-)

Finally, I want to thank my caring and dedicated family for their support all through my general education and especially for their support in my absolutely crazy project of having a child and being a mother while undertaking doctoral training. Without your help and support, I could not have managed. And to Julius, being your mother kept me sane, efficient, and eager to excel. I hope you grow up to be as proud of me, as I am of my parents.

ENGLISH SUMMARY

Co-location of industry professionals often leads to development of collaboration networks, and multiple studies have emphasized the benefits of embedded collaboration. Due to higher levels of trust, embedded collaboration reduces transaction costs and facilitates ready knowledge exchanged. Other studies have pointed to dangers of over-embeddedness. The argument is that too high levels of embeddedness lead to habitual thinking, preferential treatment, and thereby mitigate performance. However, research on the conditions under which embeddedness in different types of collaboration networks primarily yields costs or benefits still leaves much to be investigated.

The purpose of this dissertation is to provide evidence on the relationship between collaboration networks and performance, and to improve our understanding of why the benefits of embeddedness in various networks are context dependent. The thesis provides insight into the association between embeddedness in collaboration networks and outcomes under different conditions, and thereby knowledge on why embeddedness affects performance. The dissertation consists of three papers, a general introduction, and a conclusion. One paper builds on regional level data on co-location of knowledge workers, workplaces, and cultural amenities. Two papers build on individual level data from the Danish film industry.

The first paper analyses why the importance of co-location differs between groups of knowledge workers and aim to explain centralization in the urban hierarchy of city regions. The paper finds that groups of knowledge workers who face high demand for creativity, project organization, and freelancers employment, tends to be more unevenly distributed geographically. For groups of knowledge workers engaged in project collaboration, embeddedness in localized collaboration networks is so essential, it affects location choices.

The second paper challenges the proposition of embeddedness as an absolute term through an analysis of costs and benefits of embeddedness in an industry network. The results show that the association between embeddedness and performance vary with market type. In the domestic market, performance increases with embeddedness, while it decreases in foreign markets. This divergence in performance is partly caused by accumulation of context specific knowledge through localized exchange, and partly by selection bias in access to foreign markets.

The third paper addresses two questions connected to knowledge heterogeneity and innovation: First, whether individual level knowledge heterogeneity increases probability for successful innovation. Second, whether the association between knowledge heterogeneity and successful innovation depends on innovation level. The paper finds that the probability for successful stylistic innovation increases with knowledge heterogeneity but only for individuals participating in projects aiming at the creation of novelty. The probability actually decreases for individuals participating in projects aimed at product variety through incremental modifications to a predefined formula.

Cost and benefits of co-location and embeddedness depend on the type of performance aimed for. Performance type influences value of both network structures and of the exchanged resources. How resources are exchanged depends on the nature of those resources. Scarce resources such as opportunity allocation tend to follow strong embeddedness, while knowledge exchange and attention allocation follow weaker ties. Therefore, the cost-benefit tradeoff between tie development and maintenance depends on which resources are mostly needed to reach the results in question.

The contribution of this thesis is a sophisticated analysis of knowledge workers and knowledge dependent performance, which points to difficulties of sustaining competitive advantage. Co-location increases other types of proximity, which at first facilitates collaboration but over time results in

freezing cognitive and social structures. The findings in this thesis exemplify two strategies for coping and transcending such inertia. Either to develop formulas, which are either domestically or globally acknowledged as valuable outputs within their genre, or to achieve access to foreign environments in order to acquire foreign perspectives.

Interestingly, the need to avoid inertia conflicts with the tendency for high co-location of creative knowledge workers. Individual knowledge workers face the problem, that co-location provides job opportunities, access to resources, and knowledge exchange, but at the same time dulls the mind into a localized cognition which mitigates probability of reaching the path breaking creative results they aim for. One potential strategy to keep the innovative edge is mobility. However though labor mobility might benefit regions and firms, the value for individuals depends on participation in highly innovative projects.

DANISH SUMMARY

Når arbejdskraft inden for en specifik industri koncentrer sig i udvalgte regioner, bliver det lokale rammen for industriens samarbejdsnetværk. Forskning viser, at indlejring i sådanne samarbejdsnetværk ofte bidrager til værdiskabelse i projektsamarbejde. Den tillid der opbygges i samarbejdsnetværket smitter af på samarbejdet i projekter. En række omkostninger ved samarbejde --- transaktions omkostninger --- reduceres, og viden kan lettere udveksles mellem projekternes deltagere. På den anden side viser stadig flere studier, at et for højt niveau af indlejring i samarbejdsnetværk også har negative konsekvenser. Argumentet er, at en høj grad af indlejring i lukkede samarbejdsnetværk fører til vanetænkning og tildeling af ressourcer på baggrund af relationer frem for evner. Derved falder kvalitetsniveauet og resultaterne bliver derefter. Verden over arbejder forskere på at afdække, hvilke forhold, der er afgørende for, om indlejring i samarbejdsnetværk primært har positive eller negative effekter. Denne afhandling bidrager til det akademiske felts udvikling ved at undersøge forudsætninger for samarbejdsnetværk og forhold, der modificerer effekten af indlejring i samarbejdsnetværk.

Afhandlingen sigter mod at bidrage til den akademiske debat om relationen mellem indlejring i samarbejdsnetværk og resultater. Hensigten er, at forbedre vores forståelse af, hvorfor fordelene og ulemper ved indlejring af samarbejde i forskellige typer netværk er kontekstafhængig. Afhandlingen skriver sig ind i en voksende litteratur om årsager til, hvorfor netværk påvirker resultater. Afhandlingen består af tre kapitler baseret på forskningsartikler, en introduktion og en konklusion. Et kapitel er baseret på data om regional distribution af vidensarbejdere, vidensintensive arbejdspladser og kulturelle tilbud. To kapitler er baserede på data på individniveau fra den danske filmindustri.

Kapitel 2 analyserer, hvorfor vigtigheden af samlokalisering varierer mellem grupper af vidensmedarbejdere og befolkningen generelt. Kapitlet forsøger

også at forklare de observerede variationer i centralisering mellem grupperne. Resultaterne viser, at jo højere krav til kreativitet, projektorganisering og brug af freelancere en gruppe møder, jo mere ulige vil de distribuere sig geografisk. Højere krav fører til højere grad af centralisering. For de grupperinger, der er mest afhængige af projektsamarbejde og indlejring i lokale samarbejdsnetværk, bliver det så centralt et parameter i deres arbejdsliv, at det påvirker deres lokalisering.

Kapitel 3 udfordrer den gængse opfattelse af indlejring i samarbejdsnetværk som en absolut tilstand, der enten forbedrer eller forringer sandsynligheden for at opnå gode resultater. I stedet analyseres sammenhængen mellem indlejring i ét samarbejdsnetværk og salg på to forskellige markeder. Resultaterne viser, at mens indlejring i samarbejdsnetværket øger sandsynligheden for succes på hjemmemarkedet, mindsker det sandsynligheden for succes på eksportmarkeder. Denne variation i succes skyldes til dels at indlejring i samarbejdsnetværk bidrager til akkumulering af lokalt udviklet viden, og dels at indlejring i samarbejdsnetværk ofte medfører skævvridning i allokering af muligheder.

Kapitel 4 belyser to spørgsmål relateret til sammenhængen mellem individets vidensportefølje og succesfuld innovation. For det første, hvorvidt individuel vidensheterogenitet øger sandsynligheden for deltagelse i succesfulde innovationsprojekter. Og for det andet om denne relation bliver modereret af projektets innovationsniveau. Resultaterne viser, at sandsynligheden for at deltage i et succesfuldt innovationsprojekt stiger for individer med heterogen viden, men kun hvis projektet stiler mod et højt niveau af innovation. Sandsynligheden for deltagelse i succesfulde innovationsprojekter mindskes derimod, hvis projektet stiler mod et lavt niveau af innovation.

Fordele og ulemper ved indlejring i samarbejdsnetværk afhænger først og fremmest af, hvilket resultat man sigter mod. Valget af resultatmål påvirker både værdien af netværksstruktur og de ressourcer, der udveksles. Udveksling

af ressourcer afhænger af ressourcets art. Knappe ressourcer såsom allokering af muligheder har tendens til at følge stærkt integrerede netværksstrukturer, mens vidensudveksling ikke kræver samme tætte relation. Derfor vil afvejningen mellem udvikling og vedligeholdelse af netværksforbindelser afhænge af, hvilke ressourcer der er mest nødvendige.

Denne afhandling bidrager til den videnskabelige debat med en sofistikeret analyse af vidensarbejdere og resultater af vidensafhængig projektorganisering, og den påpeger grundlæggende problemer i forhold til at bevare de konkurrencefordele, der affødes af produktionens indlejring i lokale samarbejdsnetværk. Samarbejdsnetværk lokaliseret i geografiske klynger afføder også andre typer nærhed en blot geografisk. Den tætte integration fremmer samarbejde, men med tiltagende indlejring i det lokale bliver resultatet let en fastfrysning af kognitive og sociale strukturer. Denne afhandling peger på to mulige strategier til at undgå de uheldige effekter af en sådan inerti: udvikling af formler, der kan dominere som bredt accepterede standarder, og etablering af kontakter til andre relevante faglige miljøer, der kan sikre en konstant tilstrømning af nye perspektiver.

Det er interessant, at tendensen til stærkt centraliseret samlokalisering af vidensmedarbejdere er i direkte modstrid med behovet for at undgå inerti i samarbejdsnetværk. Individuelle vidensmedarbejdere står overfor den udfordring, at de centrale lokaliteter tilbyder jobmuligheder, adgang til ressourcer og udveksling af viden, men på samme tid bedøver deres nygerrighed og fastlåser dem i et lokalt paradigme. Derved kommer de selvsamme forhold, der oprindelig virkede så appellerende ved regionen, til at mindske sandsynligheden for, at de kan opnå kreative gennembrud. Den bedst mulige platform for at nå innovative resultater nås gennem mobilitet, men værdien af mobilitet begrænses af de innovative mål for de projekter arbejdskraften deltager i

CONTENTS

CHAPTER 1

INTRODUCTION

Often talent and training fail to explain all of the observed variation in success. When individual attributes do not merit the level of success, we start looking for other causes. The embeddedness of individuals in social networks and relations can provide the missing explanation: Well connected individuals tend to do better. However, who is "well connected" depends on the situation at hand. Networks function as channels for resources exchange, and while the type of transferred resources depends on types of relations, the need for various resources depends on the outcome aimed for. For example, access to scarce resources depends on trust, while knowledge exchange benefits from co-location. Depending on the pursued goal, either resource might provide a competitive advantage. However, the network structures and relations facilitating exchange of each resource differ substantially. This dissertation provides three essays on contingencies related to costs and benefits of embeddedness of economic action in different networks structures. In turn, the importance of co-location, embeddedness and linkages to foreign settings is addressed.

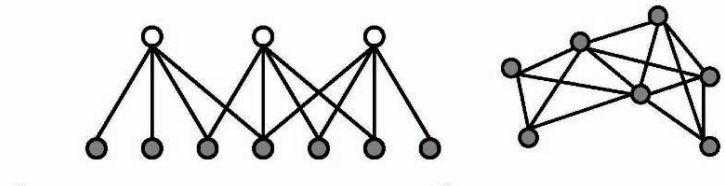
Economic action depends on social contexts because social structures and institutions affect exchange partners. In his seminal paper on the embeddedness of economic action, Granovetter (1985) promoted the idea of understanding individual action as influenced though not dictated by social

contexts. Embeddedness signifies that trust established through social interaction, experience, previous collaboration, or mutual collaboration partners affects economic action. Thereby, embeddedness in social structures and relations affects economic outcomes. Since Granovetter, several scholars within strategic management and economic sociology have demonstrated how embeddedness in networks boosts *"mechanisms of enhanced collaboration, mitigated competition, and better information exchange"* (Ingram and Roberts, 2000). Studies of embeddedness can be divided into two approaches: relational embeddedness (Ahuja, 2000; Uzzi, 1996; Uzzi, 1999; Uzzi and Spiro, 2005) and structural embeddedness (Baba and Walsh, 2010; Borgatti and Cross, 2003; Love et al., 2010; Owen-Smith and Powell, 2003; Westphal et al., 2001). Studies on relational embeddedness analyses how previous interaction (Sorenson & Waguespack 2006) or collaboration along other network relations (Jack, 2005; Uzzi, 1996; Uzzi, 1997) affects outcomes. In this dissertation, I rely on the structural embeddedness perspective. Studies of structural embeddedness analyze how access to resources depends on position in a social structure and how structural embeddedness may provide access to resources beyond those possessed by collaboration partners. A focus on structural position rather than relations take into account the whole networked setting and thereby indirect effects and status effects becomes part of the analytical framework.

A rich body of research points to general tendencies for the effects of collaboration on performance. Stylized, the argument is that strong ties and social closure benefit integration and reduce transaction costs related to communication and coordination, while weak ties and network brokerage benefit opportunity identification and knowledge exchange (Beckman et al., 2004; Bercovitz and Feldman, 2011; Burt, 1992, 2000, 2004; Coleman, 1988; Granovetter, 1973; Reagans and Zuckerman, 2001; Sosa, 2011). However, there is still a substantial gap in the research on factors modifying these general tendencies. Investigating the factors modifying the association between co-location, embeddedness, and performance of collaboration projects will contribute to a more deep and penetrating understanding of why embeddedness affects actions and outcomes. In the following chapters, associations between structural embeddedness and various types of

performance are analyzed for one specific type of networks: collaboration networks among knowledge workers. Within project based industries, collaboration networks are direct links between embeddedness of economic action and performance. Through project collaborations projects participants are linked by participation in common projects. This leads to development of industry wide affiliation networks as illustrated in figure 1.1. The white notes symbolize projects and the grey notes the project participants. Part A of figure 1.1. shows how participants are connected by projects, while part B shows the network among participants where joint affiliations to projects are the linkages.

FIGURE 1.1.
From affiliations to affiliation network.



Different positions in these collaboration structures provide access to different resources. Because co-location is an important aspect in the formation of collaboration networks, chapter 2 opens this dissertation with a study of centralization tendencies among different sub- groups of the labor force. The association between embeddedness in local collaboration networks and economic performance in different markets is studied in chapter 3, while the effect of knowledge heterogeneity acquired through foreign linkages to other regions is studied in chapter 4.

1.1. Co-Location and Embeddedness

Embeddedness in collaboration networks is strongly associated with co-location. Collaboration on projects requiring continuous adaption and integration requires face-to-face interaction (1998; Gertler, 1995, 2003; Storper and Venables, 2004). For industries where production is based on freelancers shifting from project to project, co-location also eases coordination costs (Caves, 2002). From a regional perspective, the importance of co-location of knowledge workers cannot be overestimated in a world of international competition for good ideas and their effective execution. From the individual's perspective, the importance of co-location with peers cannot be overestimated as it affects access to collaboration networks and the knowledge they incorporate (Grabher, 2006; Owen-Smith and Powell, 2004). Individuals, firms, and industries that rely on project organization of freelancers benefit the most from co-location (Grabher, 2002a, b; Lorenzen and Frederiksen, 2008; Malmberg and Power, 2005). However, existing literature neglects differences in the attractiveness of co-location and embeddedness in localized collaboration networks for various types of workers. Because the value of co-location depends on the necessity of localized collaboration networks, some groups are more receptive to co-location than others. This varies between different groups of knowledge workers, and the cause for such variations is the issue addressed in chapter 2.

1.2. Co-Location, Embeddedness and Homogeneity

Co-location increases the probability of interaction, and consequently the probability of embeddedness in common network structures and knowledge exchange. Co-location facilitates random encounters and increases the frequency of interaction (Gertler, 1995, 2003; Saxenian, 1994; Storper and Venables, 2004), and geographical proximity therefore leads to embeddedness (Boschma, 2005) --- being in the same place means being embedded in the same context. For project based industries, collaboration networks are the frameworks for production. Individuals engaged in team production need access to buzzing collaboration networks in order to stay innovative. They are

therefore attracted to the power centers of their industry – New York (marketing), Silicon Valley (semiconductors), L.A. (film production), and Boston (biotech) all benefit from this process of preferential attachment (Barabasi and Albert, 1999; Watts, 1999; Watts and Strogatz, 1998). Through participation in local educational programs and employment in local organizations, friendships arise and ideas are shared. This process leads to proximity on several dimensions of which I will here focus on the social proximity in the form of embeddedness and cognitive proximity. Cognitive proximity implies similar knowledge bases, which facilitate successful communication, understanding, and processing of exchanged knowledge. Within collaboration networks, knowledge is foremost exchanged through informal interactions (Agrawal et al., 2006; Gertler, 1995, 2003; Storper and Venables, 2004), and tacit knowledge in particular travels well through such informal channels (Sorenson and Waguespack, 2006). Consequently, socially proximate individuals tend to be cognitively proximate too and share heuristics and perspectives (Page, 2007).

Embeddedness can affect performance of projects and individuals positively because the local collaboration networks reduce transaction costs. Network formation is primarily driven by the inertia of established institutions and relations (Gordon et al., 1997; Padgett and Ansell, 1993). Commonly proposed mechanisms for network tie formation are a preference for similar collaboration partners and repeated interaction. Both mechanisms bias network dynamic towards development of homogeneous and tight knit enclaves (Dobbin, 2004). Within such enclaves, project participants possess homogeneous knowledge of the functions of the professional world they occupy, the tasks at hand, and potential problems. Such a shared world view reduces communication costs. A general level of network generated trust infuses projects with trust in form of common understanding of roles and functions and reduces uncertainty through recommendation and reputational effects (Kollock, 1994). Potential project participants can work on overlapping and subsequent project due to co-location, which reduces coordination costs. All in all this ensures smooth project management and reduces costs. Thus, embeddedness could seem to be organizations' stairway to successful projects.

However, embeddedness not only reduces transaction costs, it also mitigates the potential for identifying optimal solutions to difficult problems. The lack of difference in perspectives leave project participant with common perspectives with which to face problems arising during collaboration projects. And without diversity of perspectives, project participants end up with suboptimal solutions and thus suboptimal outcomes (Hong and Page, 2009; Page, 2007; Skilton and Dooley, 2010; Tenbrunsel et al., 1999). The consequence is, that the relation between embeddedness and performance often follows an inverted U-shape: benefits reach a threshold after which over-embeddedness increases inertia and vulnerability (Uzzi, 1996; Uzzi, 1997; Uzzi and Spiro, 2005). Furthermore, shared understanding and trust leads to bias in opportunity allocation. The development of trust among collaboration partners lead investors to grant resources and opportunities to trusted agents (Sorenson and Waguespack, 2006). Thus, embeddedness can lead to outcomes which might benefit highly embedded individuals, but are not optimal for all exchange partners. And clearly sub-optimal for project participants who are neglected based on (lack of) structural position rather than lack of abilities. However, the question of whether conditions of embeddedness and over-embeddedness are absolute or context dependent has not been explored in the existing literature. Chapter 3 analyzes this issue.

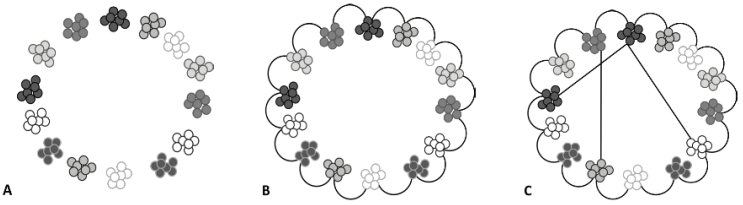
1.3. Different Perspectives and Common Ground

Knowledge heterogeneity is one vaccine against over-embeddedness. However, knowledge exchange requires some common ground for knowledge to be deemed valuable and absorbed (Cohen and Levinthal, 1990). One way to facilitate knowledge exchange is labor mobility which combines distance and proximity (Agrawal et al., 2006; Allen and Cohen, 1969; Almeida and Kogut, 1999; Bercovitz and Feldman, 2011; Breschi and Lissoni, 2009; Corredoira and Rosenkopf, 2010; Rosenkopf and Almeida, 2003; Rosenkopf and Nerkar, 2001). Labor mobility establishes communication channels, and mobility patterns function as light towers guiding attention between the firms or regions

exchanging employees. The shared interest in an employee indicates similarity in other respects. But still, the institutional or geographical distance remains. The consequence is absorption of valuable foreign perspectives which increase ability and probability of identifying optimal solutions to difficult problems (Hong and Page, 2009; Page, 2007). Studies of inter firm (Corredoira and Rosenkopf, 2010; Rosenkopf and Almeida, 2003; Rosenkopf and Nerkar, 2001) and interregional (Agrawal et al., 2006) knowledge exchange find that the resulting knowledge heterogeneity increases team, firm, and regional performance.

Figure 1.2. illustrates the value of labor mobility. 14 local industry clusters (represented by densely clustered dots) are plotted in a stylized geographical space.

FIGURE 1.2.
Access to foreign perspectives through labor mobility.



Based on Barabási 2003

In situation A, the 14 industry clusters are not linked: Within each unit there is a local network, but there is no global network. In situation B, labor flows between neighbors and industry clusters are consequently linked to their local neighbors. The global network has a high cluster coefficient (high internal clustering within the 14 units), and long average path length (it takes an average of 3.8 steps for any one cluster to access the other clusters in the global network). In situation C, labor mobility occurs across distance between a few clusters. These clusters consequently have linkages to distant clusters. This

completely alters the nature of the global network: The high internal clustering coefficient remains, but the addition of just three stretched linkages reduces the average path length between local industry clusters radically to 2.7. This provides ready access to foreign perspectives and the mobile individuals are endowed with knowledge of heterogeneous nature.

As highly innovative projects tend to involve solving more difficult problems than repetitive projects, the impact of foreign perspectives could depend on the innovative aim of projects. All projects include routine activities which benefits from integration of project participants (Caves, 2002). Integration of project participants is facilitated by repeated collaboration and by embeddedness in collaboration network which ensures a high level of mutual understanding of tasks, goals and norms (Lorenzen and Frederiksen, 2008). However, the reason for project organization of production is to facilitate optimal combinations of talent on each project and to ensure a high level of novelty through abolishing routine thinking (Skilton and Dooley, 2010). If collaboration structures freeze in predominating structures and collaboration partners become too similar, the level of innovation drops (Uzzi and Spiro, 2005). An innovative process can be compared to a process of solving a complex system of difficult problems, and optimal solutions to difficult problems are best identified through application of diverse perspectives and heuristics (Hong and Page, 2009; Page, 2007). Therefore the foreign perspectives acquired through labor mobility have greater significance for solving difficult problems than for routine tasks (Bjork and Magnusson, 2009; Burt, 2004; Gilsing et al., 2008; Powell et al., 1996). However, the impact of innovation type on the association between knowledge heterogeneity and performance is not investigated in the existing literature. Chapter 4 analyzes this relationship.

1.4. Content and Contribution

The aim of this PhD thesis is to provide evidence on the relationship between collaboration networks and performance, and to improve our understanding of why the benefits of embeddedness in various networks are context dependent. Empirical and theoretical inputs which contribute to further insights into the contingent value of embeddedness and co-location are investigated through the following sub-questions:

1. *How and why does the attraction of co-location differ between groups of knowledge workers?*
2. *When does embeddedness in collaboration networks increase performance?*
3. *How does the value of individual level knowledge heterogeneity depend on the innovative aim of project collaborations?*

These questions are addressed quantitatively through the use of econometric techniques and social network analysis. By addressing these questions, the thesis provides insight into the association between embeddedness in collaboration networks and outcomes under different conditions. The dissertation thereby provides insight into why embeddedness affects performance. Strategic use of network positions and embeddedness depend upon this understanding. The above questions are addressed in turn in chapters 2 to 4. I analyze structural embeddedness rather than relational embeddedness. Therefore relational aspects such as repeated interaction (Sorenson and Waguespack, 2006) and dyadic distance (Sorenson and Stuart, 2008) are not the focus of the analyses in chapter three and four. And the issue of location choice (Andersen, Bugge, et al., 2010; Andersen, Hansen, et al., 2010) is not addressed in chapter two.

In chapter two I, and my co-author Mark Lorenzen, analyze centrality and the co-location of knowledge workers. We try to provide explanations for why knowledge workers in settings with high levels of project collaboration have higher tendencies towards centralization. Research on urban hierarchies is a

well established tradition within the field of economic geography. Building on this tradition, we analyze the centralization tendencies of different groups of knowledge workers. Using an original database, we compare the distribution of the general population and two groups of knowledge intensive occupations across 444 city regions in 8 European countries. The results show that both the population in general and the two groups considered are distributed according to the typical rank-size rule of urban hierarchies, but exhibit different slopes and different distinct phases. The higher the demand for creativity, project organization, and use of freelancers, the steeper the slope of the distribution across city regions. This indicates that knowledge intensive groups have higher market thresholds due to specialization and need larger labor markets in central locations. The paper concludes that centrality exerts a strong influence on urban hierarchies of creativity and that the study of creative urban city hierarchies yields new insights into the problem of centrality. This paper studies dynamics at the aggregate level of regions. It points to the importance and criticality of co-location and network dynamics for knowledge intensive project collaboration.

Chapter three addresses the issue of why embeddedness in local collaboration networks is not beneficial for all types of performance. Embeddedness has been touted as a framework for knowledge exchange and innovation through collaboration, and thus as an important precondition for high level performance. Embeddedness of economic action in social structures improves access to resources, but over-embeddedness mitigates performance. However, the association between embeddedness and performance in different types of markets has until now been neglected. This paper challenges the predominant view of embeddedness and over-embeddedness as absolute and mutually exclusive conditions. Through regression analyses of novel data from the Danish film industry, the paper provides an empirical test of the association between embeddedness and economic performance in different markets. The paper finds a positive association between embeddedness and economic performance in the domestic market, but a negative association in foreign markets. This divergence is partly caused by accumulation of context specific knowledge, and partly by selection bias in access to foreign markets.

Only the very best project participants are able to circumvent a low degree of embeddedness and get their products through the industry gatekeepers to access foreign markets. But many projects by well embedded individuals are granted access to foreign markets despite low probability of success. This suggests gatekeepers base their investments on embeddedness rather than abilities, which leads to suboptimal outcomes.

Chapter four contributes to the academic debate on redundant ties versus diverse perspectives by addressing the association between knowledge heterogeneity and innovative performance. Project participants endowed with knowledge heterogeneity are more likely to contribute with diverse perspectives to team production. They are therefore more likely to be associated with successful innovation projects. Projects that aim for variety rather than creativity and novelty may, however, see coordination and communication costs associated with the inclusion of an individual with higher knowledge heterogeneity overturn the benefits. I test these propositions using data that allow us to isolate the effects of individuals' knowledge heterogeneity by exploiting temporary labor mobility between projects across country borders. I find support for the hypothesis that project participants endowed with knowledge heterogeneity are more likely to be associated with successful innovation projects. This relation is moderated by the innovative aim of the focal project. The probability of association with a successful innovation project increases for individuals participating in projects aimed at creation of novelty, and decreases for individuals associated with projects aimed at product variety based on incremental modifications to a predefined formula. The value of individual level knowledge heterogeneity is moderated by the need for smooth project management and the net effect depends on the project's innovative aim.

1.5. Overview of the Dissertation

Figure 1.3. provides a graphical representation of the issues analyzed in this thesis and how they are interlinked. The existing body of literature suggests that embeddedness in a local collaboration network leads to integration but also to homogeneity. A high level of embeddedness increases ability to navigate the local setting, accumulate knowledge and identify opportunities. Embeddedness also increases the probability of being allocated scarce opportunities. Through these mechanisms, embeddedness increases economic performance. However, the homogeneity and integration generated by embeddedness does not facilitate innovation. Rather, knowledge acquired from foreign settings provides the foreign perspective necessary to increase the probability of successful innovation. An overview of the questions and findings from all four chapters, the data, status and coauthors of the papers are presented in Figure 1.4.

FIGURE 1.3.

Overview of elements in the dissertation

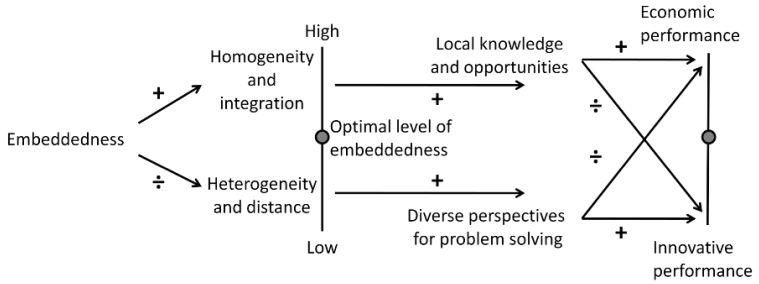


FIGURE 1.4.

Overview of chapters 2 through 4

Chapter	Abstract	Data	Status
2.	This chapter addresses the question of why professionals working in industries with high degrees of project collaboration tend to have higher clustering tendencies. The paper concludes that centrality exerts a strong influence upon urban hierarchies of creativity and that the study of creative urban city hierarchies yields new insights into the problem of centrality.	Aggregated labor market data on occupation and industries for 444 city regions in 8 European countries.	Published in Economic Geography, Vol. 85, No. 4, 2009 Coauthored with Mark Lorenzen
3.	This chapter analyzes the association between embeddedness and performance in different types of markets. I argue that a certain level of embeddedness has positive and negative effects on performance, depending on the environment in which performance is measured.	Individual level data on all projects produced by the Danish film industry released between 1995 and 2005.	Submitted to Research Policy, March 2011
4.	This chapter addresses individual level associations between heterogeneous knowledge and innovative performance. I find that knowledge heterogeneity is positively associated with participation in successful innovation, but also that this positive association is moderated by the innovative aim of the focal project.	Individual level data on all projects produced by the Danish film industry released 1995 and 2008.	Presented at DRUID PhD winter conference 2011 and CCC doctoral colloquium 2011

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CHAPTER 2

CENTRALITY AND CREATIVITY

by

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Abstract

To provide new insights into urban hierarchy, this article brings together one of economic geography's oldest and most well-established notions with one of its newest and most disputed notions: Christäller's centrality and Florida's creative class. Using a novel original database, the article compares the distribution of the general population and the creative class across 444 city regions in 8 European countries. It finds that the two groups are both distributed according to the rank-size rule, but exhibit different distinct phases with different slopes. The article argues that the two distributions are different because market thresholds for creative services and jobs are lower than thresholds for less specialized services and jobs. The article hence concludes that centrality exerts a strong influence upon urban hierarchies of creativity and that the study of creative urban city hierarchies yields new insights into the problem of centrality.

2.1. INTRODUCTION

One of the oldest problems in economic geography and a founding problem in regional science, the problem of urban hierarchy still warrants considerable attention. Harbingered by Christäller's (1933) theory of city centrality[1], economic geographers have strived for almost a century to explain the distribution of cities—in spatial, as well is as hierarchical, systems. While there has been progress, geographers cannot claim that they have made a good account of the spatial and hierarchical distribution of cities. As far as the problem of the size hierarchies of cities is concerned, it has been well described, but less well understood.

This article seeks to add new insights into the problem of urban hierarchy by contrasting a traditional analysis of the distribution of the sizes of the total populations of European cities with an unconventional analysis—that of the distribution of a particular European population group, with jobs and preferences that allegedly systematically differ from those of the rest of the population: Richard Florida's creative class (Florida 2002a, 2002b, 2002c, 2005a, 2005b, 2008). Florida (2002c, 2005a) claimed that because the creative class represents a profound shift in the nature of global competition, it also signals a new urban geography. In this article, we investigate whether the study of the creative class offers new insights into the urban hierarchy problem or whether the urban geography of the creative class exhibits hierarchical traits that are similar to those that economic geographers have been studying for almost a century.

One reason why the urban hierarchy and rank-size distribution problems have not been addressed before for the creative class is that studies of urban hierarchy require a significant number of observations (Thomas 1985). Florida's (2002c) study of the U.S. creative class included 268 cities, and until

1 In this chapter, the term centrality refers to city centrality in an urban hierarchy. The use of the term thus differs from the remaining dissertation where centrality refers to a structural position in industry collaboration networks.

recently, this study was the largest of its kind. The study presented in this article drew on an integrated database of 444 cities in 8 European countries and thus was able to investigate the urban hierarchy of the creative class and compare it to the size distribution of the general population across European cities.

Our study revealed that even if the presence of the European creative class is well correlated with the European population, its distribution constitutes an urban hierarchy that is different from that of the total population. The distribution of the creative class follows a rank-size rule, but with a steeper overall slope than that of the total population (i.e., the size of a city's creative class grows more rapidly with its rank than a city's population grows with its rank). Furthermore, the slope across the rank-size distributions is much steeper toward the tail end of the distribution for the creative class than for the total population: the creative class is less attracted to the smallest cities than the total population is. To explain the differences between the creative urban hierarchy and the urban hierarchy of the total population, the article combines Christäller's notion of centrality with Florida's notion of creativity, hypothesizing that the creative urban hierarchy is shaped by the specialized consumer and job preferences of the creative class.

In the next section, we present the theoretical background of the article, in terms of urban hierarchy, rank-size distributions, and the creative class. Then we develop two hypotheses about how the preferences of the creative class may make creative urban hierarchies different from general population hierarchies. In the following sections, we present our basic findings on the distribution of the European creative class versus the general population and use these data to test and discuss the two hypotheses. Finally, we discuss some alternative explanations for the differences between the distributions of the European creative class and the general population, followed by a short conclusion.

2.2. Theoretical Background

Urban Hierarchy

A recurrent theme in economic geography is the uneven distribution of economic activity across space. Urban (size) hierarchy—how cities differ widely in the sizes of their populations—is a prime example of such uneven spatial distribution. Consequently, a richness of spatial models, originating with Christäller (1933) and later elaborated by numerous other scholars (e.g., Lösch 1954 [1940]; Berry and Pred 1961; Tinbergen 1968; Marshall 1996), has aimed to uncover the determinants of the distributions of city size, as well as the slope of the urban hierarchies.

In the formative years of economic geography, Christäller's (1933) central place model introduced the idea that the size distribution of cities is determined by a particular relationship between the size and centrality of cities. In a country (or other geographic region), the hierarchy of the centrality of cities determines the cities' size distribution. Centrality may be modeled in different ways (for a discussion, see Davies 1967), but a generally accepted method is to use the number of a city's functions (i.e., the goods and services that the city offers). Any type of economic specialization is limited by the extent of the market (Smith 2000 [1776]), and, hence, any city function will be offered only if there are enough consumers for it. In Christäller's (1933) terminology, every city function has a distinct threshold, namely, the minimum number of consumers needed to constitute a viable market for the particular good or service. Thus, specialized city functions demand larger populations (geographic hinterlands), while less specialized functions demand smaller populations (hinterlands). In this way, Christäller and his successors not only stipulated a relationship between the number of functions of a city (the city's centrality) and the city's size, but laid out the principle of urban hierarchy: the hinterland for a city of a given centrality c (with a given number of functions) will contain several hinterlands of cities of centrality c–1 (with fewer functions).

Christäller (1933) and Lösch (1954 [1940]) also had something to say about the slope of urban hierarchies (i.e., the number of cities with centrality c–1 relative to cities of centrality c). Aimed foremost at explaining the geographic distribution of cities, their models predicted that city hierarchies that serve the maximum number of consumers from a minimum number of central cities will divide hinterlands according to a simple geometric principle, into hexagons. Each city with centrality c will divide its hinterland with the neighboring city of same centrality and serve itself plus two cities with centrality c–1. This means a distinct slope of the urban size hierarchy, too: Christäller and Lösch predicted that a hierarchy contains twice as many cities of a size that can support c–1 city functions as it contains cities of a size that can support c city functions. Christäller called this the "k = 3"-type hierarchy (one central city serves itself plus two lower-centrality cities, a total of three, in its hexagonal hinterland).

Christäller (1933) and Lösch (1954 [1940]) made stylized assumptions about the uniformity of the geographic landscape and transportation costs and of the purchasing power and preferences of consumers. Hence, their predictions of the spatial distribution of cities only rarely hold up empirically. However, one prediction holds up much better, that of clearly observable urban size hierarchies[2]. Consequently, this theme has been more eagerly pursued in economic geography (e.g, Simon 1955; Richardson 1973; Rosen and Resnick 1980; Malecki 1980; Carroll 1982; Krugman 1996a).

2 Christäller (1933) also discussed other types of hierarchies with other slopes, for example, a transportation cost-optimizing hierarchy with k = 4 (each city shares half its hexagonal hinterland with the neighboring city of same centrality) and an administration reach-optimizing hierarchy with k = 7 (each city grabs its entire hexagonal hinterland).

Rank-Size Distributions

Economic geographers' research on urban hierarchy has consistently found that urban hierarchies—whether in smaller or larger countries or even in transnational regions like Europe—conform to Christäller's (1933) k = 3 rule (e.g., Simon 1955; Krugman 1996a). The k = 3 rule is a variety of the rank-size rule[3]. Rank-size distributions, in which values steadily drop from a few observations with high values to still more observations with small values, are captured mathematically by estimating the value (size) of each observation as its rank in the hierarchy with a given exponent (Zipf 1949):

$$P(r) = k * r^{-q}$$

where P(r) is the value of an observation, r is its rank, k is a scaling constant, and q is the exponent of the distribution (inverted in the foregoing equation because it has a negative value in the rank-size distribution's downward sloping curve). The rule for an observed sample with a rank-size distribution of values is that the lower the rank of an observation, the higher its value (scaled in a way that is particular for that sample). In the sample, the negative exponent describes the downward slope of the distribution: with an exponent of -1, an observation has double the value of the observation one rank lower, and with an exponent of -2, it has four times the value[4]. Hence, Christäller's (1933) k = 3 distribution of an urban hierarchy follows a rank-size rule with the exponent of -1.

Economists (e.g., Simon 1955; Krugman 1996a) have typically evoked Gilbrat's principle of proportionate growth (Sutton 1997) to explain why urban hierarchies are distributed according to the rank-size rule: they have assumed that the growth rate of a city is higher the larger its population size and that the more pronounced this tendency, the more negative the exponent in the urban

3 Other well-known rank-size distributions in social science encompass words in the English language (Zipf 1949) and wealth in European populations (Pareto 1897; Reed 2001).
4 The mathematical expression of the rank-size rule is, given the importance of the exponent (the power to which an observation's rank is raised), also often called a power law.

rank-size distribution[5].4 To paraphrase Christäller (1933), the value of the exponent in an urban rank-size distribution depends upon the extent to which bigger cities develop specialized urban functions, serving bigger hinterlands, faster than do smaller cities. However, other possible self-reinforcing forces of larger cities are that these cities invest disproportionately in infrastructures that create advanced job options and educational opportunities, attracting a still higher number of new residents (Jacobs 1961; Florida 2002c).

Economic geography has devoted special analytical attention to the tail and the top of the distribution of the population among cities. First and foremost, it has been standard practice (e.g., Malecki 1980; Beguin 2006) to cut off the lower tail from urban hierarchies to obtain a statistically good fit to the rank-size rule (Yule 1924) because for small cities, growth may be nonproportionate (or growth rates may be so negligible) that these cities conform poorly to the rule. Furthermore, in some urban hierarchies—for instance, in small or developing economies—the one or few biggest cities have economical and possibly political primacy, monopolizing public administration, universities, and inward investments to such an extent that they are propelled beyond the proportionate growth pattern in the rest of those economies' urban hierarchies (Richardson 1973; Henderson 1988; Ades and Glaeser 1995; Krugman 1996b; Moomaw and Shatter 1996). Primary cities may thus not conform to the rank-size rule, in which case scholars typically exclude them from statistical analysis.

Two Unsolved Problems of Urban Hierarchy

The study of urban hierarchies contains a range of unsolved problems. One such problem pertains to the tail of the urban distributions. Simon (1955)

5 Strictly speaking, that proportionate growth leads to a rank-size distribution is a hypothesis, rather than a causal explanation: that proportionate growth, ceteris paribus, leads to a rank-size distribution does not imply that every real-life rank-size distribution is caused by proportionate growth. However, proportionate growth is by far the dominant hypothesis.

suggested that although scholars want to cut off the observations below the threshold (minimum city size) under which cities stop adhering to the rank-size rule in order to calculate the exponent for the urban hierarchies, they should ideally also provide a viable theory of the rank-size system's "birth rate": how and when the smallest cities grow larger than the size threshold and become a part of the urban hierarchy. Such theories have not been abundant in economic geography, however.

Another unresolved problem pertains to the slope of urban hierarchies. As we mentioned earlier, in the study of urban size hierarchies in different contexts, regional scientists have repeatedly come up with the exponent of -1 (in Christäller's 1933 term, k = 3). While proportionate growth (or what Simon 1955 called "random" growth) may explain that urban hierarchies are distributed according to the rank-size rule, the fact that distributions of different urban hierarchies all approximate the exponent -1 has not been explained, to the extent that Krugman (1996a, 417) called this situation "disturbing," "baffling," and "intriguing." With rare humbleness, Krugman added, "Suggestions are welcome."

We would like to make one such suggestion: a strategy of looking for new insights into urban hierarchy is to analyze other urban hierarchies than the one constituted by total city populations. Hence, to cast new light on the twin problems of minimum threshold levels and exponents, this article compares the distribution of cities' total populations with the distribution of a particular subgroup of the population with jobs and preferences that allegedly systematically differ from those of the rest of the population. This subgroup is Richard Florida's creative class.

The Creative Class

Florida's theory of the creative class (2002a, 2002b, 2002c, 2005a, 2005b, 2008) has made a notable impact in both the policy and scholarly worlds (e.g., Gertler, Florida, Gates, andVinodrai 2002; Andersen and Lorenzen 2005, 2009; Montgomery 2005; Boyle 2006; Raush and Negrey 2006;Weick and Martin 2006).Very simplified, Florida (2002a, 2002b, 2002c) argued that in a globalized economy in which innovation constitutes competitive advantage, it is possible to identify analytically a component of the labor force that is particularly important for competitive advantage and growth because it is technically, socially, and/or artistically creative on the job. This creative class within the labor force has particular preferences for work and private life, such as high-quality housing, work empowerment, and specialized consumption. Although the creative class shares these preferences with highly skilled labor, Florida demonstrated empirically that the U.S. creative class (which he empirically captured by selected types of jobs) has a more unique trait: it prefers to locate in cities with particularly high levels of cultural services, ethnic diversity, and tolerance toward nonmainstream lifestyles (as was captured by an array of now somewhat disputed indicators). Florida further claimed that as a result of the creative class's preference-driven pattern of location, diverse and ethnically and culturally rich cities prosper economically as innovation-intensive firms pursue the creative labor into these cities—a remarkable reversal of the industrial logic of labor-follows-capital. Florida sought to give credence to this claim by using (even more disputed) indicators of regional economic growth, such as the proportion of highly skilled labor and high-technology industries. Malanga (2004), Glaeser (2005), Peck (2005), and Scott (2006), for example, criticized Florida's argument and empirical designs.

Our purpose in this article is not to test Florida's claims about the causalities between labor and capital in a European context, because other researchers have done so using the same database as this article: Andersen and Lorenzen (2005, 2009); Andersen, Hansen, Isaksen, and Raunio (2008); and Clifton (2008) all found good correlations among the presence of a creative class, ethnic diversity, cultural services, and economic growth in a European context. Instead, we focus solely on analyzing the distribution of the creative class

across European cities. Florida (2002c) hinted that the distribution of the creative class may adhere to the rank-size rule, and together with Robert Axtell (Axtell 2001; Axtell and Florida 2006), he has since explored the microfoundations of such a distribution, applying mathematical modeling to test (successfully) if a model assuming agglomeration and proportionate growth of the creative class can produce a rank-size distribution. However, so far, there has been little empirical investigation of whether the creative class is indeed rank-size distributed and what we may learn from comparing its distribution with that of the general population.

Using a novel European data set, this article seeks to fill this gap. We investigate the creative European urban hierarchy (i.e., constituted by the distribution of the European creative class across cities), compare it to the urban hierarchy of total city populations, and seek to explain the differences between the hierarchies.

2.3. Hypotheses on the Creative Urban Hierarchy

To set our analysis in motion, we first develop two hypotheses from Christäller's and Florida's work about what a creative urban hierarchy may look like and then test these hypotheses.

The Creative Class's Specialized Consumer Preferences Influence the Creative Urban Hierarchy

Drawing on Brooks (2001) and Robinson and Godbey (1997), for example, Florida (2002b) claimed that, to a growing extent, creative people identify themselves with artists. Artists are a part of the creative class: Florida (2002b, 2002c) described the creative class as consisting of bohemians (e.g., artists, designers, and writers), engaged in applying artistic forms of creativity; a creative core (e.g., researchers, engineers, and physicians), applying mostly technical creativity; and creative professionals (e.g., managers, finance people,

and lawyers), mainly applying creativity in a generic and managerial sense (for more detailed definitions, see Appendix A). Whereas creative professionals are the largest subgroup, the creative core has the highest skill levels and accounts for most of the economic value produced by the creative class. However, even if the bohemians are relatively few and account for only a modest part of the creative class's contribution to economic growth, this group is, according to Florida, the most critical consumers of urban services. It has the most specialized preferences and pioneers the preferences of the creative class in general. Aspects of the preferences of the bohemians disseminate to the rest of the creative class, creating its "bourgeoisie-bohemian"—or, affectionately, "bobo" (Brooks 2001)—ethos.

Hence, the creative class is, allegedly, a particular and demanding consumer group, preferring high-quality and authentic consumer services and amenities—for example, nonmainstream cultural services, specialized research, and educational institutions. Thus, Florida aligned with a growing number of researchers who have argued that urban amenities (or "quality of life," as it is also sometimes referred to) play a crucial role in attracting highly productive, innovative labor, hence adding substantially to regional economic growth (e.g., Roback 1982; Glaeser, Kolko, and Saiz 2001; Lloyd and Clark 2001; Shapiro 2006).

Let us exemplify which services and amenities we are talking about. In a recent survey of the Danish creative class's consumption of cultural services[6],Bille (2007) found that the creative class consumes fewer spectator sports than does the rest of the workforce and resembles the general workforce with respect to culture consumed at home (such as television, videos, recorded music, computer games, and magazines) and mainstream public culture (such as movies, zoos, theme parks, and evening classes). However, Bille also showed

6 The survey controlled for the effects of educational level, age, gender, income level, and geographic location.

that the creative class has a significantly different pattern of consumption of specialized public culture, as is shown in Table 2.1.

Table 2.1. lists how much more likely members of the Danish creative class are to consume a range of cultural services relative to a benchmark group in the labor force (constituted by selected service occupations). It shows that the creative class is by far the most eager consumers of concerts, museums, theater, and city architecture.

TABLE 2.1
Cultural Services Consumed by the Danish Creative Class, 2004

Cultural Services	Estimated parameter for the creative class (positive likelihood relative to benchmark group)
Attend classical concerts	0.99
Visit art exhibitions	0.81
Visit art museums	0.78
Perform arts, such as music, dancing, or acting	0.63
Visit libraries	0.63
Visit museums	0.62
Visit heritage sites	0.58
Visit landscapes	0.52
Visit historical architectures	0.48
Go to the theatre	0.39
Do city walks	0.31
Walk/bike in nature or to work	0.31
Participate to sports	0.30
Attend rock/jazz concerts	0.26

Source: Bille (2007).
Note: The survey is based upon another database than the current paper, and the creative class is hence defined somewhat differently, emphasizing technical and artistic creativity. This approximates Florida's subgroups the creative core plus bohemians.

If the creative class indeed has certain specialized consumer preferences, we can hypothesize that the creative urban hierarchy will reveal them. Creative consumer preferences may, for instance, influence the lower cutoff point in the rank-size distribution. Because there are minimum efficient market sizes for particular services, there are city size thresholds below which these services cannot be found, and cities below such thresholds are likely to attract so few members of the creative class that they drop out of the rank-size hierarchy. Consumer preferences may also increase the slope of the creative urban hierarchy: the more proportionally cities' ability to offer the particular services preferred by the creative class grows with city size, the higher (more negative) exponent the distribution of the creative class is likely to have.

The Creative Class's Specialized Job Preferences Influence the Creative Urban Hierarchy

Florida (2002c) defined the creative class as "labor creating new knowledge" and captured it not through educational level but through particular occupations, as we described earlier (for more detailed occupational definitions, see Appendix A). He also stressed that contrary to industrial workers or others in less creative jobs, members of the creative class are more mobile and carefully pick their workplaces. In other words, just as they have particular consumption preferences, members of the creative class have particular job preferences. In an analogy to Christäller's (1933) idea of thresholds for specialized consumer services that we applied earlier, there are bound to be thresholds for creative jobs because there are minimum efficient market sizes for specialized creative types of jobs. Not every city needs rocket scientists or scriptwriters, which means that there are also central places and urban hierarchies with respect to creative jobs.

We hypothesize that the creative urban hierarchy will reveal the creative class's job preferences, in terms of both its lower cutoff point and slope. It may be highly influenced by city-size thresholds below which creative people cannot

find the jobs they are qualified to do: below such thresholds, cities may drop out of the rank-size city distribution. And analogous to the distribution of services discussed earlier, the more proportionally cities' ability to create creative jobs grows with city size, the higher (more negative) exponent the distribution of the creative class is likely to have.

2.4. The Urban Hierarchies of the European Population and Creative Class

In our analyses, we used an original database of the population, the creative class, and a variety of indicators of diversity, cultural services, tolerance, and economic performance in the 444 NUTS 4 city regions in 8 countries in Europe that are at comparable levels of economic development: Denmark, Finland, Germany, the Netherlands, Norway, Sweden, Switzerland, and the United Kingdom. For definitions of how we measured the size of the creative class and other variables, see Appendix A.

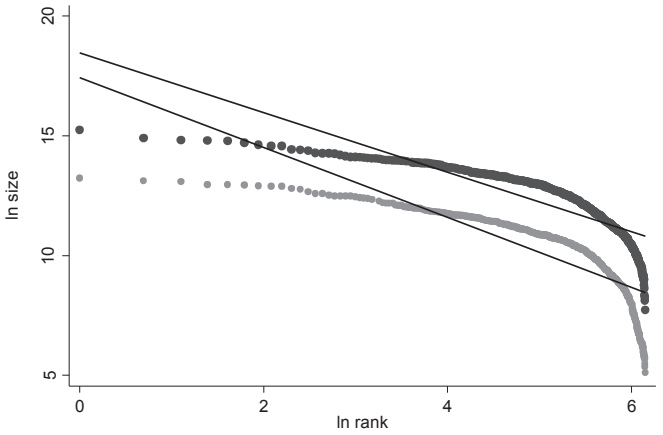
Rank-Size Distributions

At first glance, there is a good correlation between the size of the general population and the presence of the creative class in European cities; this correlation has a Pearson's r value of 0.9427. However, this overall correlation obscures some notable differences in how the population and the creative class are each distributed. We calculated these distributions for the 444 European cities in 2000 and plotted them in Figure 2.1.

Figure 2.1. shows two graphs in which the logarithms of the size of the population and of the creative class of each city are plotted against the logarithm of the rank of the city. On such a log-log plot, a perfect rank-size distribution will show as a straight line, with the exponent revealed as the slope

of the line (for information on calculating the plots used in this article, see Appendix B).

FIGURE 2.1
The rank-size distribution of the European general population and creative class (2002).



Pearsons r (Population): -0.8589***
Slope coefficient (Population): -1.244146, 95% conf. interval [-1.3116; -1.176693]
Note: Total population is shown in black, with the creative class in gray

Both the distribution of the general population and the creative class approximate rank-size rules, with fits to a perfect rank-size distribution of Pearson's r = -0.8589 and -0.8270, respectively. The creative urban hierarchy has a steeper slope than does the general population urban hierarchy; the exponent of the former's (fitted) rank-size distribution is -1.4532 compared to -1.2441 of the latter. We also calculated the distributions of the bohemians subgroup within the creative class, and while it has a similar fit to the rank-size rule (Pearson's r = -0.8240), it has an even steeper slope than does the creative class total: an exponent of -1.7606.

Top, Middle, and Tail Phases

In Figure 2.1., both distributions have a clearly visible tail with a negative deviation relative to a perfect rank-size rule. The standard exercise prescribed by regional scientists is to cut off these lower tails to obtain a better fit to a rank-size rule, and it is after this exercise that the exponent of city hierarchies usually ends up around the "magic" -1. If we cut the tails off, the remaining distributions of the population and creative class would have a fit to the rank-size rule of a Pearson's r value of -0.9185 and -0.9222. The exponents would be -0.8345 and -0.9488, respectively—close to the value of -1 that is common for urban hierarchies studied in regional science (Krugman 1996b).

However, because this solution would exclude 117 and 97 of our 444 cities for the general population and the creative class, respectively, from our samples, it is not satisfactory. Furthermore, as Figure 2.1. shows, the middles of the distributions also deviate, albeit positively, from the perfect rank-size rule, and so do the tops, again negatively. Hence, instead of cutting off the tails, we chose to divide the distributions of the total population, the creative class, and the bohemians (the latter exhibiting a similar deviating tail, middle and top) into three phases each: a top, a middle, and a tail. Figure 2.2. illustrates the distribution of the European creative class thus split up (see Appendix B for a technical explanation of how the splits were made).

Table 2.2. lists the exponent and fit to the rank-size rule for the total distribution and the three phases for the general European population, the European creative class, and the bohemians subgroup of the creative class. It also shows the number of cities included in each phase, plus the size of the population, the creative class, and bohemians in the lower threshold city, that is, where we chose to distinguish each phase from the next. Arguably, our split into three phases allowed us to capture the distributions better than if we used the regional science standard procedure of merely cutting off tails.

TABLE 2.2.
Fit, exponents, and thresholds of population, creative class, and bohemians (2002)

	Overall distribution	Top phase	Middle phase	Tail phase
General population	Pearsons r: -0.8589*** Slope coefficient: -1.2441*** 95% Conf. interval [-1.3116 ;-1.1767] N:444	Pearsons r: -0.9900*** Slope coefficient: -0.3886*** 95% Conf. interval [-.4071;-.3701] N: 39 Lower threshold: Surrey (UK), with a population of 1,061,300	Pearsons r: -0.9544*** Slope coefficient: -1.2700*** 95% Conf. interval [-1.3162; -1.2237] N:288 Lower threshold: Lohja (Finland) with a population of 77,746	Pearsons r: -0.9333*** Slope coefficient: -6.6941*** 95% Conf. interval [-7.1245; -6.2636] N: 117
Creative class	Pearsons r: -0.8270*** Slope coefficient: -1.4532*** 95% Conf. interval [-1.5431; -1.3634] N:444	Pearsons r: -0.9553*** Slope coefficient: -0.4263*** 95% Conf. interval [-.4664; -.3862] N: 46 Lower threshold: Staffordshire (UK) with a creative class of 138,524	Pearsons r: -0.9510*** Slope coefficient: -1.4409*** 95% Conf. interval [-1.4942; -1.3876] N: 301 Lower threshold: Salo (Finland) with a creative class of 7,519	Pearsons r: -0.9760*** Slope coefficient: -11.5398*** 95% Conf. interval [-12.005; -11.0745] N: 97
Bohemians	Pearsons r: -0.8240*** Slope coefficient: -1.7606*** 95% Conf. interval [-1.8708; -1.6504] N:444	Pearsons r: -0.9766*** Slope coefficient: -0.6928*** 95% Conf. interval [-.7392; -.6465] N: 46 Lower threshold: Mittelfranken (Germany) with a bohemian population of 5,670	Pearsons r: -0.9636*** Slope coefficient: -1.7070*** 95% Conf. interval [-1.7602;-1.6538] N: 309 Lower threshold: Tromsø (Norway) with a bohemian population of 167	Pearsons r: -0.9581*** Slope coefficient: -16.1033*** 95% Conf. interval [-17.0090; -15.1975] N: 89

= 0.05 significance level (twosided), *= 0.01 significance level (twosided)

After this split into three phases, we found that the three phases in all distributions now fit remarkably well to a perfect rank-size rule. For example, the creative class's top, middle, and tail phases have Pearson's r values of -0.9553, -0.9510, and -0.99760, respectively[7].

Relative Diseconomies of Top and Tail Cities

Another benefit of the split is that we can take a closer look at the behavior of the distributions for the cities with highest and lowest values. There are interesting insights here: the three phases for all distributions (the general population, the creative class, and the bohemians) exhibit strongly and significantly different exponents[8]. All three distributions have a higher (more negative) exponent for the tail phase and a lower (less negative) exponent for the top phase. Hence, European cities seem to suffer from some relative diseconomies of small or large populations. Since all phases are rank-size distributed, we may assume a proportional growth (that is, the larger a city, the higher its growth). However, for the tail and top cities, such proportional growth is notably less than for the middle cities.

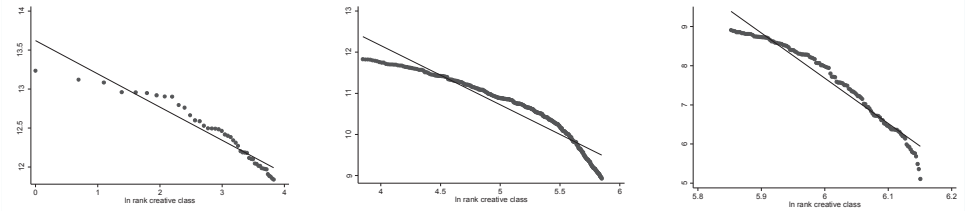
Thus, for the top cities, the positive-growth effect of increasing size tapers off (for each higher rank, the proportionate growth falls). These diseconomies are modest: the exponent drops (becomes less negative) by 70 percent from the middle phase to the top phase. However, it still means that the distributions of the European population and creative class exhibit no urban primacy. Contrary

7 Splitting up the distribution ad infinitum would, of course, create still better statistical fits but yield less and less insight. We chose to split up the distributions into three and only three phases because of the clear negative deviation in the top, positive in the middle, and negative in the tail.

8 We calculated the 95-percent confidence intervals of the exponents for the different phases, delimiting the interval in which we are 95-percent sure that the exact value of the exponent is found. There is a significant difference between the exponents of two phases if their 95-percent confidence intervals do not overlap. None of the tested exponents does.

to the S shape of urban hierarchies with primacy (Stewart 1958; Vapnarsky 1969; Rosen and Resnick 1980; Carroll 1982), the top European cities slightly underperform[9]. This underperformance of the top phase (70 percent lower, less negative exponent relative to the middle phase) is similar for the general population and the creative class.

FIGURE 2.2.
Phases of the rank-size distribution of the European creative class (2002)



N: 46	N: 301	N: 122
Pearsons r: -0.9553***	Pearsons r: -0.9510***	Pearsons r: -0.9760***
Slope coefficient: -0.4263**	Slope coefficient: -1.4409**	Slope coefficient: -11.5398

The diseconomies are much stronger for the smallest cities, evidenced by the high (strong negative) exponent of the tail phase. In this phase, for each lower rank, the size of the population and the presence of the creative class drop more dramatically than for middle cities. The tendency of cities to drop off steeply at the tail is more profound for the creative class than for the general population. The tail phase of the creative class distribution has 8 times the negative exponent of the middle phase and 27 times that of the top phase. Hence, from the middle phase to the tail phase, the negative exponent of the creative class distribution grows 801 percent, compared to 527 percent for the

9 That the distribution shows no urban primacy is not surprising because the database integrates city data for eight European countries. The integration of data blurs the effects of potential urban primacy within each country. Of the individual countries, only Finland exhibits urban primacy for the distribution of the population and the creative class (Andersen, Hansen, Isaksen, and Raunio 2008).

general population. Whatever the diseconomies of small cities may be, they are 1.52 times stronger for the creative class than for the general population.

2.5. Test of Hypotheses

As we discussed, the creative urban hierarchy is distinctive from the general population hierarchy in a fundamental way. Its slope is steeper: exponents of both the total distribution and the three phases are higher (more negative) for the creative class. In the following sections, we explore possible reasons for this difference through testing the hypotheses stated earlier.

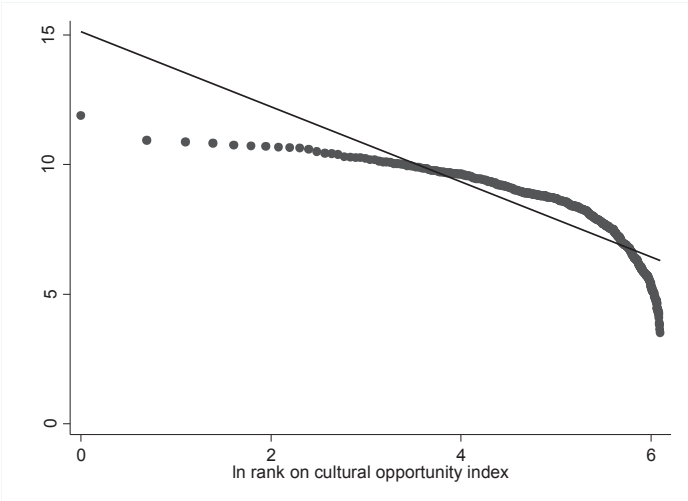
Hypothesis 1: The Creative Class's Specialized Consumption

One explanation for the steeper slope (more negative exponent) observed for the creative urban hierarchy may be found in Hypothesis 1: the specialized consumption of the creative class.

A simple way to test whether the creative class's consumption influences the creative urban hierarchy is to correlate the distribution of services with the distribution of the creative class. To do so, we chose a type of consumption that has been claimed to be particularly important to the creative class: cultural services. We calculated a cultural opportunity index for the European cities, measuring their economic activity in restaurants, cafés, entertainment, museums, and so on (for details, see Appendix A). The distribution of this index across European cities correlates well with the distribution of the creative class: a Pearson's r value of 0.8202. This correlation is better than the correlation of the cultural opportunity index with the general European population, which has a Pearson's r value of 0.6887. Both correlations are significant at a high level ($p = 0.01$).

With such a strong and significant correlation of the presence of cultural opportunities and the European creative class, we can confirm the hypothesis that specialized consumption in the guise of cultural offerings influences the European creative urban hierarchy in a more powerful way than it influences the general population.

FIGURE 2.3
The rank-size distribution of European cities' cultural opportunity index (2000).



N: 444
Pearsons r: -0.8613***
Slope coefficient: -1.4474**

To investigate the effect of such influence, let us look closer at the distributions of the creative class and cultural services. Hypothesis 1 suggests that there may be minimum market sizes for particular services that are demanded more by the creative class than by the general population. If this hypothesis is true, it would explain the dramatic (negative) growth of the exponent in the tail city phase of the creative class's distribution and hence account for the creative class's higher (more negative) overall exponent

compared to that of the general population. Figure 2.3. presents the distribution across European cities of the cultural opportunity index. Evidently, one more rank-size distribution is observed here — one that we can split into three phases with different exponents. The exponents, fits, and thresholds of the phases are presented in Table 2.3.

This exercise illustrates the minimum efficient market sizes for cultural services in Europe. There is a notable drop-off of the cultural opportunity index, as well as its exponent, from the middle phase to the tail phase. In the tail phase, many cities have too few creative inhabitants to constitute sufficient consumer bases to sustain the specialized services that are demanded by the creative class.

TABLE 2.3
Fit, exponents, and thresholds of phases of the European cities' cultural opportunity index (2000)

	All regions	Top regions	Middle regions	Tail
Pearsons r	- 0.8613***	-0.9739***	:-0.9572***	-0.9628***
Slope coefficient	-1.4474**	-0.4702**	-1.4391**	-7.9040
N	444	40	280	124
Lower threshold		Northamptonshire with 17.487 employees in the cultural sector	Ystad/Simrishamn (Sweden) with 878 employees in the cultural sector	

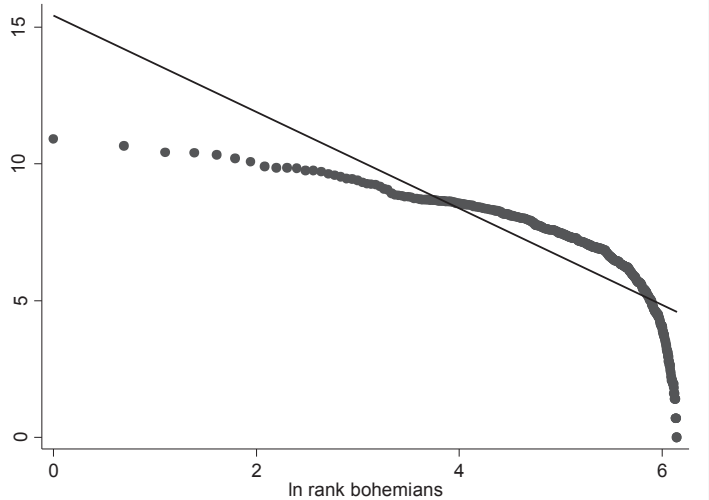
* 0.1 significance level (two-tailed), ** 0.05 significance level (two-tailed), *** 0.01 significance level (two-tailed).

The effects are much more profound for the "canary in the coal mine" when it concerns creative consumption—the bohemians. Figure 2.4. shows the rank-size graph of the distribution of the bohemians across the European cities.

This distribution can also be split up into three phases. As Table 2.2. shows, bohemians account for the most dramatic drop-off in the tail phase of all the

distributions, with a negative exponent much higher than the total creative class and almost double that of the general population. From the middle phase to the tail phase, the negative exponent of the bohemians' distribution grows by 943 percent, compared to 815 percent for the creative class and 535 percent for the general population. Hence, the adverse effects of small numbers for the bohemians are 1.16 times those of the total creative class and 1.76 times those of the general population. Because of the bohemians' preferences for consuming even more specialized services than the rest of the creative class, this group is the first to shy away from cities with poor services (Florida 2002b, 2002c).

FIGURE 2.4
The rank-size distribution of European bohemians (2002).



N: 468
Pearsons r: -0.8240***
Slope coefficient: -1.7606*

Hypothesis 2: The Creative Class's Specialized Job Preferences

Another reason why the creative urban hierarchy has a steeper slope than the general population hierarchy may be found in Hypothesis 2: the creative class's specialized job preferences.

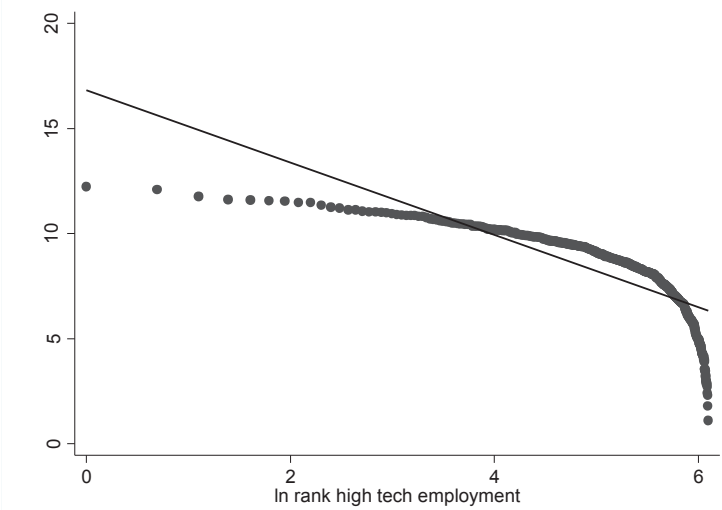
In the same way that we tested Hypothesis 1, we first correlated the distribution of the creative class with a proxy for specialized jobs. While the creative class works in a broad range of industries, it has, as Florida (2002a, 2002c) defined, a creative core, occupied with research and development in high-technology industries (defined as industries with high research-and-development intensities). Hence, as a proxy for specialized jobs, we constructed an index based on high-technology workplaces (for details of what we included as high technology, see Appendix A). The distribution of the high-technology index across European cities correlates well with the distribution of the creative class: a Pearson's r value of 0.8812. This correlation is slightly better than the correlation of the high-technology index with the general European population, which has a Pearson's r value of 0.8374. Both correlations are significant at a high level ($p = 0.01$).

The presence of the creative class in European cities correlates even better with the presence of high-technology workplaces than it does with cultural services (which had a Pearson's r value of 0.8202). Hence, specialized job preferences in the guise of preferences for high-technology jobs may well influence the European creative urban hierarchy. However, it also seems that such preferences are largely shared by the general population, since the differences in correlation are modest. This means that although we can support the hypothesis that specialized job preferences in the guise of preferences for high technology jobs influence the European creative urban hierarchy, there is no strong support for claiming that a preference for specialized high-

technology jobs is the factor that makes the overall creative urban hierarchy look different from that of the general population hierarchy[10].

However, when we look more closely at the tail ends of the distribution of the creative class and the high-technology job workplaces, the picture changes remarkably. Figure 2.5. plots the distribution of the number of high-technology workplaces in European cities.

FIGURE 2.5
The rank-size distribution of European cities' number of high-technology workplaces (2000).



N: 444
Pearsons r: -0.8243***
Slope coefficient: -1.7202*

10 Our proxy, high-technology jobs, is only part of the story. There are many other specialized types of jobs that may disappear with a declining city size and may affect the distribution of the creative class more than the general population.

The distribution of high-technology workplaces in European cities follows a rank-size rule and demonstrates three phases with different exponents. The exponents, fits, and thresholds of the phases are presented in Table 2.4.

TABLE 2.4
Exponents, fit, and thresholds of phases of the European cities' number of hi-tech workplaces (2000)

	All regions	Top regions	Middle regions	Tail regions
Pearsons r	- 0.8243	-0.9867***	-0.9602***	-0.9496***
Slope coefficient	-1.7202*	-0.5126**	-1.6876**	-14.9251
N		41	295	108
Lower threshold		Franken (Germany) with 33,567 employed in the high tech sector	Visby (Sweden) with 910 employed in the high-technology sector	

* 0.1 significance level (two-tailed), ** 0.05 significance level (two-tailed), *** 0.01 significance level (two-tailed).

There is a dramatic drop-off of high-technology workplaces at the tail of the distribution: the negative exponent of the distribution of high-technology workplaces grows by 885 percent from the middle phase to the tail phase. Following our analogy to Christäller's (1933) argument (presented earlier), we can explain this drop-off by virtue of market thresholds. In the tail phase, we begin to see the effect of labor market thresholds because cities here have too few members of the creative class to constitute viable labor markets for high-technology jobs. The dramatic drop-off of high-technology jobs in the tail end of its distribution coincides with the equally dramatic drop-off of the presence of the creative class in the tail end of the latter's distribution. This finding suggests, but does not prove, that there may be a particularly strong effect of the creative class's preferences for high-technology (and other specialized) jobs

and that this effect is partly a cause of the differences in the distributions of the European general population and the creative class[11].

2.6. DISCUSSION

In this section, we discuss a few alternative explanations for the differences between the creative urban hierarchy and the general population hierarchy.

Slope, Proportional Growth, and Social Networks

We used arguments of centrality (about market thresholds for creative services and jobs) to explain why the distribution of the creative class has a steeper slope than that of the general population. However, there are, of course, alternative explanations. One such explanation focuses on social networks.

If we accept proportionate growth as a general explanation for rank-size distributions (and, as we discussed earlier, this is not an unproblematic explanation), the argument for the rank-size distribution of the creative class in this case is "creative begets more creative": cities with a higher number of creative people are particularly good in attracting more creative people. The social network theory (e.g., Wasserman and Faust 1994; Burt 1992; Barabási, Albert, Jeong, and Bianconi 2000; Barabási 2002; Watts, Dodds, and Newman 2002) offers some insights into why creative people would be particularly good in attracting each other. In accounting for how networks grow, this theory outlines the principle of preferential attachment: the nodes with the most preexisting links to other nodes are strongest in attracting new links (Barabási 2002). Where network nodes are people and network links consist of social

11 Because the tail ends of the distributions of high-technology workplaces and the creative class do not necessary contain the same cities, they cannot be directly compared.

relations, ceteris paribus, the larger the population of a city, the more social relations it will have to outside people. Because the number of moves to a city is often proportional to the number of social relations between old and new or potential residents (Gans 1962;Tilly 1990; Granovetter 1995; Portes 1995; Gold 2001), bigger cities, which have more network relations, attract the most newcomers. In this social network perspective, the reason why the creative class has a high proportional growth is that creative people are often the network nodes with the most links (not the least because much creative work is organized in temporary projects [Lorenzen and Frederiksen 2005]), and hence a particularly high potential for attracting more creative people (Uzzi and Spiro 2005; Powell, White, Koput, and Owen-Smith 2005).

The growth of the number of members of the creative class in a city may not just be due to geographic mobility; it may also be due to job mobility. For example, an information technology (IT) engineer who is hired by a big corporation to do development work instead of maintenance, a graduate who is starting his or her own company, or a writer who is finally realizing his or her artistic aspirations by getting a manuscript published in effect shifts job type into the creative class category. For this type of growth of the creative class, the importance of social networks also causes a significant proportionate growth of the bigger cities: cities with more networks yield the most entrepreneurial opportunities (Burt 1992; Granovetter 1995; Casson and Giusta 2007). This line of argument aligns well with the observations on entrepreneurship and city growth in economic geography (e.g., Klepper 2002; Håkansson 2005).

The social network proposition should be subjected to future testing. It should also be noted that while this alternative explanation may account for the higher overall exponent of the distribution of the creative class, it does not offer much by way of explaining the differences among the exponents of the three different phases in the two distributions. Here, centrality seems a much more fruitful explanation.

Small-City Diseconomies and Political Representation

There is one possible alternative explanation for the drop-offs in the tail phase of the distribution of the creative class. Florida (2005b, 2008) proposed that the creative class is keen on influencing change and, hence, that its influence in professional and public decision making may also play a role in its choice of location[12]. May such a preference for political influence of the creative class explain the relative diseconomies of the cities with the smallest presence of the creative class (i.e., the dramatic growth of the negative exponent in the rank-size distribution)? Does the creative class shy away from small towns because it enjoys less representation there?

To conduct a tentative test of this proposition, we used the share of the creative class in the local workforce as a proxy for the strength of its influence. Ceteris paribus, the higher the share of the creative class, the higher its influence on professional, everyday, and political life, as well as on political decisions on the use of public spaces, funds, and other resources. Figure 2.6. shows the European cities, ranked by the size of their creative class, plotted against the share (in percentage) of their resident labor force constituted by the creative class[13].

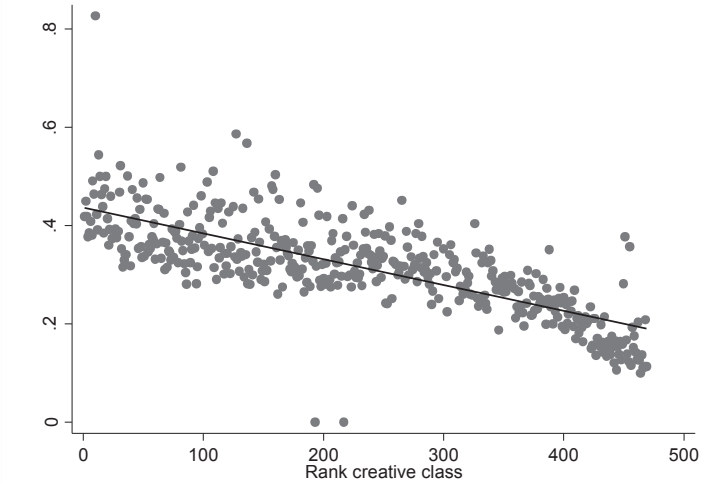
As we reported earlier, the distribution of the general population and the creative class are well correlated: as the population size of cities drops, so does

12 The fact that the creative class may influence whether public resources are used in ways that allow for and stimulate creativity, by building particular amenities, for example, of course adds to the (alleged) proportional growth of cities that have a high presence of the creative class.

13 The reason for presenting the correlation between cities' shares of the creative class and cities' creative class size ranks—but not absolute sizes—is pragmatic. The correlation between size and share of the creative class has a much lower correlation coefficient. It does so because of the different scales; for example, there may be a great difference in size between a city with rank 1 and a city with rank 10 but only a small difference in size between a city with rank 101 and a city with rank 110.

the creative class. In Figure 2.6., we show that the correlation between the size rank and the share of the creative class has a Pearson's r value of -0.7781. For city regions with the smallest creative class (ranks higher than 400), there is a clear tendency for the error terms to be negative because most observations are under the regression line. This finding indicates a slight drop in share—and thus the possible political representation—of the creative class for the city regions with the smallest presence of the creative class. However, since there is no significant drop-off in the share, we cannot argue that there is a size threshold under which the creative class rapidly looses political representation.

FIGURE 2.6
European cities' creative class size rank versus the share of the creative class (2002).



N: 444
Pearson's r: -0.7791***

In sum, although political representation may matter, we cannot demonstrate that it should be a factor in causing the rapid drop-off of the exponent in the tail phase of cities with a small creative class. Nor does the idea of political

representation offer any explanation of why we can also see a drop-off of the exponent in the tail phase of the general population's distribution. Centrality is again the most reasonable explanation for this phenomenon.

Large-City Diseconomies and Congestion

In our analysis, we focused on the problem of the relative diseconomies of the smallest cities—the drop-off in the tail of the distributions of the population and the creative class. However, as we outlined earlier, there is also a small drop-off in the top of the distributions. Why are there slight diseconomies of the largest cities, preventing them from enjoying the same effects of proportionate growth as the middle-sized cities do?

The explanation may simply be urban congestion. While there are scale economies of urban infrastructures up to a certain point, the largest cities, which are also the cities with the highest growth rates, may be chronically behind with respect to investing in basic infrastructures. Ironically, the most populated cities that have managed to develop world class specialized urban functions and infrastructures, such as universities and airports, sometimes lack basic infrastructures, such as public transportation capacity and pollution control (and sometimes crime control). Even more important, housing prices and other living costs grow disproportionately in large cities with high growth rates. As Colby (1933), Myrdal (1957), and Hirschman (1958) argued, such urban congestion serves to spread or "centrifuge" growth from large cities, and we may trace such centrifugal effects in the drop-off in the rank-size exponent in the top of the distributions of the population and the creative class.

Our data did not allow us to test whether congestion is the reason for large-city diseconomies. It was not possible to obtain data on land rents, pollution, traffic delays, or other proxies for congestion for the European cities in our database (we could not even obtain this information for the biggest European

cities). However, a range of qualitative interviews that we conducted in connection with the quantitative analysis did exemplify members of the creative class who, in their choice of location, balance the diversity in services and job offers of the largest cities against congestion (Andersen and Lorenzen 2005, 2009; Andersen, Hansen, Isaksen, and Raunio 2008).

Although Florida (2002c, 2005b, 2008) presented no empirical evidence, he proposed that the creative class, who have higher average incomes and more frequently work in temporary projects and shifting workplaces (Lorenzen and Frederiksen 2005), may be more geographically mobile than the general population. However, our data provide no indication that congestion effects in the largest cities counteract the growing attractiveness of city size most for the creative class: the diseconomies of the top cities are about the same magnitude for the general population and for the creative class.

2.7. Conclusion

This article has brought one of economic geography's longest-standing problems, urban hierarchy, together with one of its newest, most hyped, and most criticized ones, the creative class. Using a novel original database of 444 European cities in 8 countries, we departed from the usual approach in regional science and analyzed both the urban hierarchy of the general European population and the creative urban hierarchy of the distribution of the creative class. Although some of Florida's claims about the creative class may be unsubstantiated, we wanted to investigate whether analyzing the distribution of the creative class offered any new insights into the urban hierarchy problem. We found that it did: even if the European creative class is a subset of the total European population, the urban hierarchy of the European general population and the urban hierarchy of the European creative class are quite distinctive. The rank-size distribution of the creative class indicates a greater proportionate growth (it has a steeper overall slope) than

that of the general population's and the slope across the creative class's distribution suggests that it has greater diseconomies of small cities.

We developed and tested two hypotheses that combined Christäller's idea of centrality with Florida's idea of creativity.

The creative class's specialized consumer preferences influence the creative urban hierarchy because of market thresholds for creative amenities and services. We found a good correlation between the distribution of the creative class and an index for specialized cultural services, as well as clear lower thresholds for cultural opportunities, which we argued (partly) accounts for the dramatic transition of the distributions of both the total creative class and its most critical consumers, the bohemians, into tail phases with strong diseconomies (strong negative exponents). Owing to these influences upon the creative urban hierarchy, we accepted the hypothesis as true.

The creative class's specialized job preferences influence the creative urban hierarchy because of labor market thresholds for creative jobs. We found an even better correlation between the distribution of the creative class and an index for specialized jobs and a noticeable lower threshold for these jobs, and we argued that this finding partly explains the strong negative exponent in the tail end of the distribution of the creative class. Owing to these influences upon the creative urban hierarchy, we also accepted this hypothesis as true.

In addition, we briefly discussed some alternative explanations for the distribution in the European creative urban hierarchy: the creative class's social network structures, big-city congestion, and the creative class's alleged search for political representation.

Although the article does not provide answers to the pending questions regarding urban hierarchy, it offers some new insights. Concerning the question of the slope of rank-size urban hierarchies, it demonstrates that whereas urban total population hierarchies approximate an exponent of -1, it makes sense to study other hierarchies that are embedded in population hierarchies because they may have other exponents (in our case, the creative urban hierarchy did). Furthermore, the article proposed that rather than cut off the lower tails of urban hierarchies and ponder cities' "birth into the rank-size system" (Simon 1955), regional scientists could instead study transitions between different phases, all within the same system. Instead of cutting off the lower tails of distributions, we divided them into phases with different exponents. Consequently, we were able to capture the fact that even if some rank-size distributions may have similar overall exponents, they may still behave differently near their tail and top. We can imagine distributions of other social phenomena with phases that all follow the rank-size rule, but with different exponents. For example, among the richest or poorest few of a country's population, wealth may attract more wealth in a much more dramatic way than is the case for the middle class. Students of such phenomena should not seek to cut off the lower tail of observations but instead find the transitions between the phases with different exponents.

To explain why the distributions of the European population and the creative class exhibit different phases, particularly lower phases with strong negative exponents, we applied Christäller's (1933) insights, analyzing market thresholds for specialized consumer services and for specialized types of jobs. However, we departed from Christäller's strong assumption of uniform preferences and assumed instead that the market thresholds for the services and jobs preferred by the creative class systematically differ from the thresholds for less specialized services and jobs and consequently exert an influence on the creative urban hierarchy. In short, leaning on both Christäller and Florida, we argued that centrality exerts a strong influence on urban hierarchies of creativity.

Appendix A: The Database and the Definitions Used

The data used in this article are the result of a common European project with participation from Denmark, Finland, Germany, the Netherlands, Norway, Sweden, Switzerland, and the United Kingdom. We chose countries with a high level of economic development for reasons pertaining to the availability of data to avoid large effects of different political regulation regimes upon the distribution of the creative class and problems in integrating data from economically less-developed countries with high urban primacy with countries with more perfect rank-size urban hierarchies (for problems of incorporating less developed countries into such data sets, see Soo 2005).

Partners from all of the countries participated in developing the variables in the data set to ensure the best possible homogeneity among the European countries and possibilities for comparability between European and North American analyses of the creative class. The source of the data varies among the European countries. Data for the Nordic countries (Denmark, Finland, Norway, and Sweden) are register data supplied by the national statistical bureaus, containing accurate information on the whole population. For the remaining countries, data are national census data supplied by the national statistical bureaus, containing information on a substantial and representative sample of the national populations.

To ensure comparability among the European countries, the city region is used as the unit of analysis. Although the European countries use slightly different definitions of a city region, all of the definitions correspond to Eurostat's NUTS 4 regions. NUTS 4 (which after 2003 are called "Local Administrative Units, level 1") are, in fact, not administrative but functional regions that should capture metropolitan regions akin to those used by Florida (of course, there are subtle differences between EU countries in how NUTS4/LAU1 are defined statistically). Hence, the NUTS 4 region is an appropriate regional unit for minimizing cross-regional travel-to-work and other spillovers. The majority of people living in one NUTS4 region are likely to work and use the services in that region.

The point of departure for each variable in the data set is the indicators that Florida (2002c) developed and presented in his analyses of the creative class. This article uses the following variables:

Population: number of all inhabitants (residents).

The creative class: the share of the employed residents within creative professions defined by the ISCO codes 245 (journalism, art, and writing), 3131 (work with sound, light, and pictures related to photography, film, and theater), 347 (work in art, entertainment, and sports), 521 (modeling), 211 (work in physics, chemistry, astronomy, meteorology, geology, and geophysics), 212 (work in mathematics and statistics), 213 (IT planning and development), 214 (architecture and engineering), 221 (work in biological natural science), 222 (work in medicine, odontology, veterinary science, and pharmaceuticals), 231 (university and college teaching), 232 (high school teaching), 233 (elementary school teaching), 234 (specialty teaching), 235 (other work related to education), 243 (work related to information and the distribution of culture), 244 (work in social sciences, humanities, and high-level social work), 247 (work related to administration of the law within the public sector), 1 (high-level management), 223 (midwifery and high-level nursing), 241 (work related to the organization and economy of business), 242 (work in law), 31 (technical work in nonbiological areas), 32 (technical work in biological areas), 341 (high-level sales and marketing), 342 (business services), 343 (administrative work), 345 (work related to police investigation), and 346 (work related to social guidance and care).

Cultural opportunity index: the number of employees in a city region working in industries with NACE 553 (restaurants and related activities), NACE 554 (bars, nightclubs, cafés, and related activities), NACE 921 (film and video), NACE 922 (television and radio), NACE 923 (other entertainment), NACE 925 (libraries, archives, museums, and other cultural activities), and NACE 926 (sports).

High-technology jobs: the share of the employees in the city region who work in high-technology industries defined as the NACE codes 244 (manufacture of pharmaceuticals, medicinal chemicals, and botanical products), 300 (manufacture of office machinery and computers), 321 (manufacture of

electronic valves and tubes and other electronic components), 322 (manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy), 323 (manufacture of television and radio receivers, sound or video recording or reproducing apparatus, and associated goods), 331 (manufacture of medical and surgical equipment and orthopedic appliances), 332 (manufacture of instruments and appliances for measuring, checking, testing, navigating, and other purposes, except industrial process control equipment), 333 (manufacture of industrial process control equipment), 334 (manufacture of optical instruments and photographic equipment), 335 (manufacture of watches and clocks), 341 (manufacture of motor vehicles), 342 (manufacture of bodies [coachwork] for motor vehicles and manufacture of trailers and semitrailers), 343 (manufacture of parts and accessories for motor vehicles and their engines), 353 (manufacture of aircraft and spacecraft), 642 (telecommunications), 721 (hardware consultancy), 722 (software consultancy and supply), 723 (data processing), 724 (database activities), 725 (maintenance and repair of office, accounting, and computing machinery), 726 (other computer-related activities), 731 (research and experimental development in the natural sciences and engineering), 732 (research and experimental development in the social sciences and humanities), 742 (architectural and engineering activities and related technical consultancy), 743 (technical testing and analysis), and 921 (motion picture and video activities).

The creative class is further divided into three subgroups:
The creative core: the share of the employed residents within specific (technical or educational) creative professions defined as the ISCO codes 211, 212, 213, 214, 221, 222, 231, 232, 233, 234, 235, 243, 244, and 247.
The creative professionals: the share of the employed residents occupied within specific (generic or managerial) creative professions defined as the ISCO codes 1, 223, 241, 242, 31, 32, 341, 342, 343, 345, and 346.
Bohemians: the share of the employed residents within specific (artistic) creative professions defined as the ISCO codes 245, 3131, 347, and 521.

Appendix B: The Methods Used in Calculating and Plotting the Distributions

A rank-size distribution is a correlation of the size of a variable for a group of observations with the rank of those observations on the same variable. We used a mainstream method (see, e.g., Gabaix 1999; Gabaix and Ioannides 2004) to calculate and plot the distribution of the creative class, the total population, cultural services, and high-technology jobs among the 444 European cities.

All of the cities were ordered by the value of the observation (i.e., of the number of members of the creative class, the total population, those employed in cultural industries, and those employed in high-technology industries—for definitions, see Appendix A). The largest observation was given rank 1, the second largest rank 2, and so forth. We plotted the values as a graphic plot, placing the log of the rank on the y axis and the log of the size of the corresponding observation on the x axis. As Gabaix and Ioannides (2004, 6) noted, perfect rank-size distributions should then appear as "something very close to a straight line." This is an indication that the distribution is scale free (Barabási and Albert 1999).

One may choose to cut off the lower tail of observations if it has no scale-free distribution to obtain a fit to a rank-size rule (Gabaix 1999)—or, as in the case of our analysis, in which no cutoff was made, it may be necessary to split up the distribution into phases with a better fit to the rank-size rule.We chose to divide our distributions into three phases because they all exhibit a clear tail phase with a negative deviation relative to a perfect rank-size rule, a middle phase with a positive deviation, and a top phase with a negative deviation.

We cut off at the point where the error term of the observations shifts sign, that is, the top and bottom of the middle phase is defined by the shifts of the error term from positive to negative. This statistical method is not aimed at optimizing the statistical fit of each phase to the rank-size rule (the method for doing so would be more complex); rather, it is meant to be a simple way of ensuring that we can compare the three phases and their fits across different analyses, such as comparing the cutoff points and fits of the total population to those of the creative class. The number of observations in each phase of the distributions is not so small as to cause any statistical problems (e.g., the

smallest phases are the top ones, where N = 39 and 46 for the total population and the creative class's top phases, respectively).

Copenhagen, December 2010

To whom it may concern,

The authors hereby certify that the paper entitled '"Centrality and Creativity: Does Richard Florida's Creative Class Offer New Insights into Urban Hierarchy?', published in ECONOMIC GEOGRAPHY, Volume: 85(4), pp. 363-390, is based on equal contributions by the respective authors, Andersen and Lorenzen.

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CHAPTER 3

THE PROBLEM OF EMBEDDEDNESS REVISITED: COLLABORATION AND MARKET TYPES

by

Kristina Vaarst Andersen

Abstract

Embeddedness has been touted as a framework for knowledge exchange and innovation, and thus as an important precondition for high level performance. Embeddedness of economic action in social relations improves access to resources, but over-embeddedness impedes performance. However, the association between embeddedness and performance in different markets has until now been neglected. This paper challenges the predominant view of embeddedness and over-embeddedness as absolute and mutually exclusive conditions. Through regression analyses of novel data from a project based industry, the paper tests the association between embeddedness and economic performance in different markets. The paper finds a positive association in the domestic market, but a negative association in foreign markets. This divergence in performance is partly caused by selection bias in access to foreign markets, and partly by accumulation of localized knowledge.

3.1. Introduction

Networks are channels and conduits for resource exchange (Owen-Smith and Powell, 2004), and embeddedness of economic action in social relations increases access to resources and thereby improves performance. Positive associations between embeddedness and performance have been identified for agglomerations (Eisingerich et al., 2010), organizations (Ahuja, 2000; Gilsing et al., 2008; Mahmood and Zheng, 2009), and individuals (van Rijnsoever et al., 2008). And this positive association holds for performance measured as number of patents (Gilsing et al., 2008), allocation of opportunities (Granovetter, 1973; Sorenson and Waguespack, 2006), power over peers (Burt, 1992), quality of collaboration partners (Ahuja et al., 2009), general economic growth (Eisingerich et al., 2010), and career progress (van Rijnsoever et al., 2008). There are several reasons for this positive association. Embeddedness affects opportunity recognition, as interaction affects perception of options (Gregoire et al., 2010). Embeddedness also affects development of abilities, as interaction partners provide access to and shapes knowledge accumulation (Brown and Duguid, 2001; Owen-Smith and Powell, 2004). Furthermore, embeddedness affects opportunity allocation, as trusted exchange partners tend to be favored (Sorenson and Waguespack, 2006).

Many findings support a positive association between embeddedness and performance, but a growing number of studies also point to decreasing benefits of increasing embeddedness levels and others even argue that too high levels of embeddedness lead to over-embeddedness and suboptimal outcomes (Gargiulo and Benassi, 2000; Grabher, 1993; Laursen and Salter, 2006; Masciarelli et al., 2010; Owen-Smith and Powell, 2003; Uzzi, 1997; Uzzi and Spiro, 2005). The argument is that too much reliance on embeddedness results in suboptimal outcomes (Skilton, 2008; Skilton and Dooley, 2010; Tenbrunsel et al., 1999). Over-embeddedness is argued to mitigate diversity and thus innovative potential. Recognizing that embeddedness in network structures yields both costs and benefits has lead researchers to investigate the optimal level of embeddedness in networks. It has, for instance, been claimed that optimal levels of embeddedness depend on the task at hand (Gargiulo and Benassi, 2000; Mizruchi et al., 2011).

However, there has practically been no work recognizing that the value of given resources varies across markets. No prior research has investigated whether the optimal levels of embeddedness and thresholds for over-embeddedness depend on the markets in which performance is measured. In this paper I contest the predominant view of embeddedness and over-embeddedness as absolute and mutually exclusive terms, which either increase or mitigate performance. Instead, I propose that optimal levels of embeddedness depend on the market in question. Providing evidence in support for this view facilitates a more detailed understanding of the interplay between project organization, project participant's attributes, and performance. Comparing economic performance on distinct markets allows for analysis of variations in the association between embeddedness and economic performance and for investigating underlying mechanisms. The paper addresses discrepancies between findings from previous studies, and provides the potential explanation of differences in market performance, thereby contributing to the discussion on embeddedness of economic action in collaboration networks.

Empirically, I address the association between embeddedness and economic performance across markets by analyzing the association between a participant's embeddedness in the collaboration network of the Danish film industry and the film's economic performance on the domestic market and foreign markets. Production of film is organized as projects of freelancers and thus the film industry provides an optimal setting for studying collaboration network outcomes (Faulkner and Anderson, 1987) such as embeddedness and over-embeddedness. Employing a zero-inflated count model, I find a positive association between embeddedness and economic performance on the domestic market. However, on foreign markets, the association between embeddedness and economic performance is negative. The association between embeddedness and total economic performance (both markets combined) is positive and embeddedness is positively associated with selection for distribution on foreign markets. This indicates that the negative association between embeddedness and economic performance on foreign markets is

caused by selection bias in access to foreign markets. But also, that embeddedness in a local network of knowledge exchange does not benefit performance in foreign contexts.

The paper is organized as follows, sections 3.2. gives the theoretical background and hypotheses. Section 3.3. describes applied data and methods. Section 3.4. presents the results, which are discussed in section 3.5. Section 3.6. concludes the paper.

3.2. Theoretical Background

Individual's likelihood to participate in economically successful projects is affected by resources exchange through collaboration networks. Various types of embeddedness in collaboration have been shown to benefit performance on the level of agglomerations (Eisingerich et al., 2010), organizations (Ahuja, 2000; Gilsing et al., 2008; Mahmood and Zheng, 2009), projects (Cattani and Ferriani, 2008) and individuals (van Rijnsoever et al., 2008). However, individual level embeddedness is the foundation for creation of relationships at all other levels, and thus insight into mechanisms and consequences of individual level embeddedness generates knowledge of general value. Individuals can be --- and are --- embedded in a multitude of relations, but understanding of associations between embeddedness and economic performance will benefit the most from a focus on professional collaboration. Such professional collaboration networks facilitate exchange of scarce resources in the form of knowledge, attention allocation, and opportunities. This exchange is fundamental to the claim, that embeddedness positively affects performance. Embeddedness has been associated with performance measured as number of patents (Gilsing et al., 2008), opportunity allocation (Granovetter, 1973; Sorenson and Waguespack, 2006), power over peers (Burt, 1992), quality of collaboration partners (Ahuja et al., 2009), general economic growth (Eisingerich et al., 2010), and individual career progress (van Rijnsoever et al., 2008). The following subsections outline mechanisms behind the costs

and benefits of being embedded and over-embedded, and relates this to market types.

Benefits of Being Embedded

Embeddedness in collaboration networks leads to several positive mechanisms benefitting performance. First, embeddedness in collaboration networks decreases transaction costs and improves project management, and embeddedness therefore tends to be positively correlated with performance. The embeddedness of economic transactions in collaboration networks decreases transaction costs through reduction of search costs and coordination costs. This is essential to project based industries where the constant recombination of talent in different project teams is essential to satisfy the demand for innovative products (Caves, 2003). In these settings, team formation is eased by embeddedness in professional collaboration networks because knowledge exchange within project teams decreases the coordination and search costs for subsequent projects and facilitates the matching process. Furthermore, embeddedness facilitates development of shared norms and produce opportunities for social sanctions which mitigate the risk of opportunistic behavior (Dobbin, 2004). For the participant, this limits the room for potential action, but it also creates a general level of trust benefitting all participants in the network. Because embeddedness in collaboration networks eases project collaboration, it, in turn, increases participant's potential for association with high performing projects.

Second, being embedded in collaboration networks enhances exposure to knowledge exchange. From the perspective of knowledge exchange, the value of embeddedness lies in access to knowledge and the thereof following ability to produce better products. Through collaboration, project participants exchange knowledge either directly through interaction or indirectly through observation. Embeddedness in collaboration networks provides access to fast flowing streams of tacit knowledge (Polanyi, 1962, 1966) and increases development of individual abilities (Eisingerich et al., 2010; Tortoriello and

Krackhardt, 2010). Therefore, direct connections to central participants will facilitate knowledge accumulation (Borgatti and Cross, 2003; Owen-Smith and Powell, 2003). Exposure to rich flows of knowledge, in turn, develops the participant's abilities to absorb and utilize new knowledge (Escribano et al., 2009). The process enables participants to accumulate knowledge about collaboration practices, consumer tastes, and internalization of norms specific to the network (Gertler, 2003; Storper and Venables, 2004). Regardless of whether embeddedness enforces the ability to learn (learning to learn) or whether the accumulated knowledge eases the absorption of new knowledge (Cohen and Levinthal, 1990), the end result is the same: collaboration allows participants to accumulate knowledge. The more experienced participants and their collaboration partners are, the more knowledge is available for exchange during collaborations. Thus, embeddedness increases both knowledge stock and knowledge exchange. The exchanged knowledge may not enable participants to do their job better in an objective sense, but assists them in developing the abilities to perform better within the paradigms of the environment in which they are embedded (Cattani and Ferriani, 2008).

A third potential benefit of being embedded is improved access to scarce resources. Within economic sociology, embeddedness has often been analyzed as structural positions improving performance due to either opportunity recognition or opportunity allocation. Selection of collaboration partners is based on social psychological mechanisms such as biased perceptions of abilities, symbolic signaling and status, rather than rational assessment of qualities (Cattani and Ferriani, 2008; Tenbrunsel et al., 1999). In the selection of collaboration partners, positive symbolic features increase interest, while irrational stigma decreases interest (Alhakami and Slovic, 1994; Pontikes et al., 2010). This behavior increases with the difficulty of obtaining the necessary information for informed decision making, because high search costs lead to a tendency for the human brain to settle for signals (Ben-Ner et al., 2009). Signals are easy to recognize and interpret, and travel well through networks. Actual abilities are difficult and time consuming to assess, which means that project participants tend to place their trust in potential collaboration partners who are well known in the network in order to reduce search costs (Dyer and

Chu, 2003). Personal knowledge, previous positive experience with a collaboration partner or common third party, is not a guarantee of future success. Nevertheless it infuses trust (Kollock, 1994). This suboptimal decision process influences opportunities for all participants. Reliance on signals leads to although allocation of opportunities based on embeddedness in collaboration networks rather than abilities of project participants (Sorenson and Waguespack, 2006).

Regardless of how these three mechanisms manifest and interact, the existing literature points to, that higher levels of embeddedness should lead to improved economic performance. This leads to hypothesis H1:

H1: A project participant's level of embeddedness in a collaboration network is positively associated with economic performance.

Costs of Over-Embeddedness

A growing stream of research provides evidence, that too high levels of embeddedness mitigate performance (Bathelt et al., 2004; Boschma, 2005; Gargiulo and Benassi, 2000; Masciarelli et al., 2010). This condition of over-embeddedness can refer to a individual's too strong reliance on a few exchange partners, too many redundant ties or --- as in this case --- too strong structural embeddedness in a network.

In collaboration networks, homophily and redundant ties will increase knowledge homogeneity which leads to decreased creativity and consequently lower levels of performance. First, project participants tend to prefer collaboration with similar others (Hedegaard and Tyran, 2011), and interaction with peers ensures a common framework for understanding new knowledge and eases knowledge transfer (Cohen and Levinthal, 1990). Over-embeddedness therefore implies a high proportion of redundant ties to a relative homogeneous group of closely linked project participants. Networks both transfer and filter knowledge and allow only the knowledge which is deemed valuable is allowed to pass. With increasing homogeneity of

perspectives among exchange partners, the exchanged knowledge becomes increasingly homogeneous. Furthermore, there is a tendency to accept knowledge that does not contradict shared perspectives and, consequently, this type of knowledge diffuses through networks too. Intensity of interaction and similarity of knowledge are related (Lin, 2001). This adds to the lack of variety in perspectives and input within close knit networks which increases with the isolation, closure, and density of the network. Accumulated knowledge will tend to be consistent with dominant perspectives and experiences in the network. Consequently, we should expect high levels of embeddedness in collaboration networks to lead to accumulation of homogeneous knowledge and socialize participants into specific local paradigms. For project participants strongly embedded in collaboration networks, this implies that the assortment of exchanged knowledge provides advantages in the shape of increased quality and reliability, but disadvantages in the shape of decreased diversity. This is the disadvantage of embeddedness: it can lead to network imposed blindness and result in poorer performance (Kautonen et al., 2010). Network imposed blindness becomes more critical as the uncertainty of the environment and strength of the competition increases.

Second, embeddedness affects opportunity allocation, and too high levels of embeddedness will therefore not lead to selection of the most able, but rather of the most embedded. Human beings tend to exert greater resistance to potential risks than attraction to potential gains, which leads to risk adverse behavior (Alhakami and Slovic, 1994). Therefore there is a tendency to assess the abilities of trusted collaboration partners more highly and to grant them more and better resources (Delmestri, 2005; Dyer and Chu, 2003; Granovetter, 1973; Sorenson and Waguespack, 2006). Consequently, previous collaboration partners are preferred and we tend to assess those we know or are related to through network ties more favorably. These two dynamics – preference for known collaboration partners and misconception of their qualities - support the tendency to allocate more and better resources to embedded individuals. Embeddedness increases both the number and the quality of collaboration partners, and amplifies knowledge about individuals. As a consequence, central individuals enjoy higher levels of trust and have a higher probability of

obtaining the necessary resources. The result is, that opportunities tend to be allocated based on embeddedness in collaboration networks, which does not necessarily guarantee the abilities for optimal utilization of these opportunities. This lead to hypothesis 2:

H2: A project participant's level of embeddedness in a collaboration network is subject to declining marginal benefits.

Market Types, Cost and Benefits of Being Embedded

When access to foreign markets has been gained, the costs of being embedded in the local setting persist but the benefits decrease. Knowledge accumulated in the local context is of little benefit as foreign markets are characterized by highly diverse demand and entrants lack knowledge of institutions, competitors and demand (Eriksson et al., 1997). The uncertainty is not intrinsic to those foreign markets, but rather a consequence of entrants suffering from the liability of foreignness (Freeman et al., 1983; Lu and Beamish, 2001). In the domestic market participants benefits from accumulated knowledge suited for the predominant paradigms, and the specialization and homophily endowed by strong network embeddedness is beneficial. However, faced with markets of high uncertainty in form of unknown competition, diverse demand, and the liability of foreignness, the benefits of accumulated knowledge decrease. This decreases benefits of knowledge accumulated through network collaboration.

The mechanisms of opportunity recognition and opportunity allocation also decrease in value in foreign markets. Embeddedness improves opportunity recognition in the domestic market due to access to private information, but in foreign markets, locally embedded participants have no special access to private information. Furthermore, they do not have the necessary perspectives to interpret the signals they do receive (Page, 2007). In the domestic market, embeddedness also increases performance through opportunity allocation. But in foreign markets, the local agents and institutions granting opportunities have little power. They do function as gatekeepers and can provide access to foreign markets. However, once participants are on foreign markets, their connections and prominence in the local network is of no consequence. Embeddedness

becomes over-embeddedness if the cost-benefit trade-off shifts after gaining access to foreign markets. This will be the case as the costs of embeddedness remains while benefits decrease. The costs of high levels of embeddedness will therefore outweigh the decreasing benefits. This leads to hypothesis 3:

H3: A project participant's high levels of embeddedness in the industry's collaboration network will decrease economic performance on foreign markets.

3.3. Data and Method

The association between embeddedness and economic performance is analyzed using data from the Danish film industry. Due to its project based organization a creative industry such as the film industry is an optimal setting for studying network dynamics such as embeddedness (Faulkner and Anderson, 1987). The project organization increases the need for reduction of transaction costs by reliance on professional collaboration networks. Collaboration networks can be seen as manifestations of the underlying social structures (Owen-Smith and Powell, 2003) --- blueprints of the channels for knowledge transfer.

Data

The data were provided by the Danish Film Institute, which is responsible for decisions about subsidies (amounts and type). All productions and distributors are legally obliged to report to the Danish Film Institute. Some variables are available to the public, via the Danish Film Institute's annual statistical publications; others are from the Danish Film Institute's internal data bases. Relational variables are constructed in UCInet based on records of collaboration. The data cover the period 1995 to 2005. The first five years (1995-1999) are used to create a basic industry network. Thereafter, the network measures are based on a seven year rolling window (five years for 2000, six years for 2001) with a one year time-lag: the level of embeddedness in

year x is assumed to be related to selection into projects in year x+1. The analysis includes all the key participants in the film production process. Thus participants are actors (limited to the five leading actors), directors, producers, screenwriters, cinematographers, composers, and editors. These freelancers work on 'shifting' projects and over time become embedded in a collaboration network (Ferriani et al., 2009). Within the Danish film industry, projects are generally initiated by a director or jointly by a director and a producer. They are based either on the director's vision or on material adapted by a screenwriter, selected by the director and/or producer. Following this initial phase, actors, cinematographers, composers, and editors are hired to work with the core team on production and post production. Films are defined as Danish based on the nationality of the production company (cross country collaborations with substantial Danish participation would be similarly designated).

Dependent Variable

The dependent variable is the economic performance of each participant-project combination. Empirically, economic performance is measured as the number of admissions (number of tickets to cinema shows). Although a high level of admissions does not guarantee profit, the number of admissions is an indicator of the level of the commercial potential and economic performance of a film (Caves, 2003; DeVany and Walls, 1997; DiMaggio, 1977; Ferriani et al., 2009). Economic performance is measured for the domestic and foreign markets, and combined for both markets. Economic performance should not be interpreted as an indicator of focal participants' contribution to a project. Projects combine many skills and inputs in a complex process. Rather, economic performance indicates the combined selection and contribution to projects.

Participants face fierce competition in both domestic and foreign markets. In the domestic market the Danish film industry holds a rather large market share of approximately 30% of total cinema admissions, which is among the highest domestic market shares in Europe. However, competition from film

production in other European countries and especially North America, is tough and leads to an increasing shortening of viewing windows. Approximately half of all observations achieve access to foreign markets and the correlation between performance in the domestic and foreign markets is significantly positive but weak at 0.195.

Key Variables

Embeddedness: The concept of embeddedness covers both structural and relational embeddedness. In this paper, embeddedness is defined as structural embeddedness and focuses on the participant's position in the overall network. Some of the existing research measures structural embeddedness as network positions defined by patterns of interaction (Baba and Walsh, 2010; Love et al., 2010; Westphal et al., 2001), or participation in common activities (Owen-Smith and Powell, 2003). As the analysis in this paper is based on the entire industry collaboration network I am able to incorporate both perspectives and define structural embeddedness as the position in the industry collaboration network. A tie is defined as project collaboration (what could also be termed participation in a common activity or patterns of professional relations. Examples of this definition of ties include Delmestri, 2005; Ferriani et al., 2009; Pontikes et al., 2010; Sorenson and Waguespack, 2006; Usai, 2001).

As the path length between project participants increases, the size of a participant's network also increases. But the probability of knowledge exchange or mobilizing resources decreases with increasing path length (Lin, 2001; Wasserman and Faust, 1994/1997). To capture this important aspect of embeddedness within the collaboration network, embeddedness is measured as eigenvector closeness centrality (for an example of an application of the eigenvector centrality measure see Ferriani et al., 2009). The eigenvector closeness centrality measure is based on each participant's closeness to all other members of the network. For the network (adjacency matrix) A, the eigenvector centrality of participant i (c_i), equals

$$c_i = \alpha \sum A_{ij} c_j$$

where α is a parameter equal to the reciprocal eigenvalue (Borgatti, 2002). The eigenvector centrality of each participant therefore depends on the eigenvector centrality of its linked participants (c_j). Being central in a central part of the network, therefore, results in a higher score than being central in a small cluster within the network. The normalized eigenvector centrality is calculated as "the scaled eigenvector centrality divided by the maximum difference possible, expressed as a percentage" (Borgatti, 2002).

Embeddedness SQ: The literature on over-embeddedness finds evidence of a decreasing effect of embeddedness for performance (Masciarelli et al., 2010; Uzzi and Spiro, 2005), and thus the squared eigenvector measure is included in some of the models to test for whether the relation is linear or curvilinear.

Domestic: The model includes a dummy variable for whether the observation is for the domestic or foreign market. This variable is used to create the interaction term for performance in the domestic and foreign markets. Apart from the fact that only about half of all participants get access to foreign markets, these markets are highly uncertain due to more diverse consumer tastes and increased and unpredictable competition.

*Embeddedness*Domestic:* To identify the differences in association between embeddedness and economic performance within the domestic and foreign markets, models include an interaction term for the eigenvector measure and a dummy for performance measured as domestic admissions.

*Embeddedness SQ*Domestic:* To identify differences in the effect of embeddedness in the two markets, models include an interaction term between the squared eigenvector measure and the dummy for performance measured as domestic admissions.

Controls

Promotion: The domestic marketing budget is included in the model as an indicator of the allocation of opportunities. Previous research shows that the

allocation of opportunities affects performance (Sorenson and Waguespack, 2006). Promotion budget is in 1000000 dkk.

CineClub: Each year a few Danish productions are chosen for inclusion in Cinema Club Denmark. Inclusion in Cinema Club Denmark boosts a film's number of admissions, but the revenue for Club admissions is lower. I include the variable CineClub as an indicator on allocation of opportunities to boost the number of admissions (though not necessarily economic performance).

Domestic admissions: Success in the domestic market will influence performance and exposure in foreign markets. Therefore a dummy for Domestic admissions is included in the zero-inflation part of the models.

Domestic awards: Participation in projects earning domestic awards might boost tickets sales and thus economic performance in both the domestic and in foreign markets. It might also affect the decision to distribute the product on foreign markets. Therefore a dummy for Domestic awards is included.

New entrant: Professionals new to the industry might receive disproportionate attention from critics and the media (Cattani and Ferriani, 2008). Especially if they enter from a related industries (e.g. theatre) or other film clusters (e.g. Hollywood). To account for this possible effect I created a dummy variable New entrant which indicates entry in the year of observation.

Production Budget: Availability of resources is likely to affect the quality of the films produced. Due to lack of information on production budgets, previous research often uses a lagged dummy for box-office receipts to control for resource availability (Ferriani et al., 2009 use this strategy, while Sorenson and Waguespack 2006 limit their analysis to observations on which they have budget data). Since I have production budget data for almost all the films released in the period analyzed, I include production budget in 1000000 dkk to control for availability of resources.

Distribution company: The type of distributor could influence the participant's performance since majors have more monetary resources as well as professional skills for distribution in foreign markets (Ferriani et al., 2009; Litman, 1983). I differentiate among three types of distribution companies: national companies, regional Scandinavian/Nordic companies, and

international companies (majors and companies in exclusive alliance with international companies).

Genre: As child/youth/family targeted productions tend to attract larger audiences (Cattani and Ferriani, 2008; Ferrari, 2007; Ferriani et al., 2009; Ravid, 1999), a dummy for participation in films belonging to these genres is included in the models.

Language: Participation in film projects where English is the main language is most often aimed at international distribution of the final product, and thus such participants could be expected to experience higher levels of admissions on foreign markets. Therefore the models include the dummy English.

Sequel: Sequels have the possibility to capitalize on the interest created by the original/previous film. However, on average, sequels tend to have higher costs and earn less than the original film. In line with other research (Cattani and Ferriani, 2008; Ferriani et al., 2009; Ravid, 1999) the variable sequel indicates whether a participant participates in an original film project or a sequel.

Type of subsidy: Few Danish film projects are achievable without some form of subsidy. The Danish Film Institute provides subsidy for nearly all projects based on either artistic merit (judged by an internal consultant), or commercial criteria (based on predictions of return on investment). The type of subsidy indicates the type of project the individual participates in. Subsidies are awarded at a relatively early stage in the development process. Not all films that receive a subsidy are realized and assumptions as to creative value or probability of profit may not hold true. However, the type of subsidy received is an indicator of the original intention of the film project.

Year and period: Due to the Danish film industry's dependence on state subsidy, I include a dummy that distinguishes between periods with different negotiated subsidy terms. I also include year dummies to control for the variation in cinema attendance and the popularity of Danish films(Ferriani et al., 2009).

Model

The purpose of this study is to uncover whether a project participant's structural embeddedness in the collaboration network is related to economic performance in terms of theater admissions, and how this relation differs between the domestic and foreign markets. In order to investigate these associations, I carry out an individual level study in which I explain the number of admissions using a measure for structural embeddedness in the industry network. The data are organized at the individual level which means that each participant-project combination is registered twice - once for domestic performance and once for foreign performance. To compare the association between embeddedness and performance in the domestic market with embeddedness and performance in foreign markets, I employ an approach in which I interact the embeddedness variable with the domestic market dummy. The model can be written as:

$$y=f(x, d, x*d, c),$$

where y is the number of admissions, x is the measure of embeddedness, d is a dummy for the domestic market and c is a vector of the control variables. This model specification allows a statistical assessment of differences in the effect of embeddedness in general and the effect on domestic market alone. Since the dependent variable is a count, I consider a Negative Binomial and a Poisson model specification. Also, approximately half of the observations considered are never exposed to foreign markets, a situation which generates a large number of zeros on the dependent variable. Therefore, I considered zero-inflated versions of the above mentioned models. Voung statistics (significantly positive) favor a zero-inflated model, and the likelihood-ratio test for Alpha (significantly positive) indicates over-dispersion. Therefore, I choose a zero-inflated negative binomial model. As co-variation is common across projects I control for clusters by project title. All the estimations considered are robust using the Huber-White-sandwich technique to correct for heteroskedasticity.

3.4. RESULTS

Descriptive statistics and Pearson correlations are displayed in Table 3.1. and the estimated models 1-6 are presented in Table 3.2. Following a hierarchical estimation strategy, Model 1 only includes control variables and the dummy for domestic observations, the embeddedness variable is added in Models 2.

The interaction between embeddedness and the domestic market dummy is added in model 3. The squared term of embeddedness in model 4, and the interaction of the squared term and the domestic market dummy in model 5. Model 6 estimates effects for the total economic performance on both the domestic and foreign markets combined.

Hypothesis 1 predicted a positive association between embeddedness and economic performance in the domestic market. The positive estimate for embeddedness in model 2 does not distinguish between the domestic and foreign markets, but model 3 tests the hypothesis. The interaction term between embeddedness and domestic market is significantly positive in model 3. This shows a positive association between being embedded in the collaboration network and high levels of economic performance in the domestic market. The interaction effects is also significantly positive in model 4 which includes the squared embeddedness term, and positive though only on a 10% significance level in model 5 which includes both the squared embeddedness term and its interaction with the domestic market dummy.

Hypothesis 2 predicted decreasing benefits of embeddedness, which is tested through including the squared embeddedness term and its interaction with the domestic market dummy in model 4 and 5. Neither model 4 nor model 5 show any significant effect of the squared embeddedness term or its interaction with the domestic market dummy.

Hypothesis 3 predicted a negative association between embeddedness in the collaboration network and economic performance in foreign markets. Model 2 includes the main effect of embeddedness, but it does not distinguish between markets and I thus turn to model 3 to test this hypothesis. Model 3 and 4 both show significant negative association between embeddedness and economic performance in foreign markets. The effect continues to be negative though not significantly so when the squared embeddedness term and its interaction with the domestic market dummy are included in model 5.

Model 6 predicts effects of embeddedness for the total economic performance in both the domestic and foreign markets, and shows a significantly positive association between embeddedness and performance.

The estimated control variables indicate that participation in projects granted a subsidy for artistic merit, and films made in English have higher economic performance. Finally, participation in projects rated as children's or family films increases performance, but performance varies between years and over periods.

The inflation part of model 2 shows a significantly negative association between embeddedness and the probability of a zero outcome (the inflation parts of model 4 and 5 are equivalent to model 2). For the probability of a zero outcome predicted by the zero-inflation parts of the models, the availability of resources measured by the production budget has a negative effect, as does a high level of domestic admissions. The variable domestic awards has no significant effect. Participation in films made in English, family films and artistic productions decreases the probability of a zero outcome. The inflation parts of the models predict a zero-outcome= probability of no access. This suggest that high levels of embeddedness are associated with higher likelihood of not being a zero and hence that the film is launched on the foreign market.

TABLE 3.1.
Means, Standard Deviation, and Pearson Correlations.

	Variable	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13
Dependent variable																
(1)	Econ. performance	140151	347209													
Key variables																
(2)	Embeddedness	4.23	6.58	.01												
(3)	Domestic	.5	.5	.06	.00											
Controls																
(4)	Promotion	1.314	.51	.25	.16	.00										
(5)	CineClub	.13	.33	.31	.03	.00	.14									
(6)	Dom. admission	159960	160668	.38	.16	.00	.63	.45								
(7)	Dom. awards	.13	.33	.32	-.01	.00	.09	.24								
(8)	New entrant	.41	.49	-.02	-.53	.00	-.14	-.03	-.03							
(9)	Prod. budget	18.52	20.95	.33	-.01	.00	.09	.29	.04	.03						
(10)	Regional distb.	.60	.49	-.19	.08	.00	-.18	-.09	-.16	-.03	-.18					
(11)	Int. distb.	.21	.40	.03	-.04	.00	.17	-.13	.05	-.01	-.14	-.62				
(12)	Family genre	.28	.45	.01	-.05	.00	.21	-.24	-.24	-.01	-.09	-.06	.19			
(13)	English	.06	.24	.29	.02	.00	.02	.16	.16	.03	.36	.04	-.13	-.16		
(14)	No subsidy	.03	.17	-.03	.01	.00	-.07	-.07	-.07	-.01	.17	-.10	.04	-.11	-.05	
(15)	Art subsidy	.60	.49	.06	-.10	.00	-.32	-.02	.31	.07	-.08	.07	-.11	-.11	.11	-.22

Note: Based on 2350 observations. Correlations estimates above 0.05 or below -0.05 are significant at a 5% level, two-sided test. Dummies for years and periods omitted.

TABLE 3.2.
Results of zero-inflated negative binomial regression (ZINB), number of admissions.

	(1) Controls Only				(2) Without interaction				(3) With interaction			
	Main model		Zero-infl.		Main model		Zero-infl.		Main model		Zero-infl.	
Key variables												
Embeddedness					.006**	(.003)	-.013**	(.007)	-.017**	(.009)	-.021***	(.008)
Domestic	.329	(.280)			.331	(.281)			.185	(.288)		
Embeddednes*Domestic									.033***	(.012)		
EmbeddednessSQ												
EmbeddednessSQ*Domestic												
Controls												
Promotion	2.154***	(.211)			2.143***	(.209)			2.134**	(.208)		
CineClub	.798***	(.193)			.800***	(.193)			.814***	(.194)		
Domestic admissions			-2.4e-06***	(8.65e-07)			-2.3e-06**	(8.5e-07)				
Domestic awards	.600**	(.233)	-.473	(.710)	.606***	(.232)	-.487	(.706)	.609***	(.230)		
New entrant	-.013	(.047)	.006	(.084)	.034	(.049)	-.082	(.083)	.033	(.048)	-.048	(.084)
Production budget	22.2e-05	(.006)	-.014*	(.007)	2.00e-04	(.006)	-.014*	(.007)	-2.03e-04	(.006)	-.015	(.008)
Regional distributor	-.085	(.322)	-.515	(.335)	-.093	(.322)	-.494	(.337)	-.089	(.319)	-.399	(.379)
Int. Distributor	-.083	(.338)	-.310	(.381)	-.083	(.337)	-.305	(.380)	-.078	(.333)	-.434	(.423)
Family genre	.678***	(.181)	-.603*	(.316)	.690***	(.183)	-.622**	(.316)	.693***	(.181)	-.602**	(.290)
English	.906**	(.384)	-21.293***	(.547)	.908**	(.384)	-21.9***	(.547)	.906**	(.379)	-21.2***	(.523)
No subsidy	-.241	(.267)	-.016	(.615)	-.238	(.267)	-.020	(.616)	-.227	(.267)	.108	(.832)
Art subsidy	.282	(.188)	-.819***	(.274)	.285	(.188)	-.825***	(.275)	.285	(.185)	-.711***	(.253)
Constant	7.726***	(.483)	1.542***	(.408)	7.690***	(.487)	1.607**	(.409)	7.790**	(.489)	1.138***	(.455)
Number of obs.			2350				2350				2350	
Number of zeroes			649				649				649	
Log ps.likelihood			-22573.46				-22571.44				-22593.16	
Alpha			2.6e+08***				2.6e+08***				2.5e+08***	
Vuong			54.35***				54.64***				47.84***	
Wald chi			313.67***				314.80***				332.67***	

Standard error between parentheses. *p<0.10; **p<0.05; ***p<0.01 significance levels at a one sided tests for key variables and two sided tests for control variables

TABLE 3.2. Continued
Results of zero-inflated negative binomial regression (ZINB), number of admissions.

	(4) Interaction and squared				(5) Interaction and squared interaction				(3) Total economic performance	
	Main model		Zero-infl.		Main model		Zero-infl.			
Key variables										
Embeddedness	-.018*	(.012)	-.013**	(.007)	-.033	(.029)	-.013**	(.007)	.013***	(.004)
Domestic	.185	(.289)			.160	(.285)				
Embeddednes*Domestic	.033***	(.012)			.052*	(.032)				
EmbeddednessSQ	4.18e-05	33.58e-05			.001	(.001)				
EmbeddednessSQ*Domestic					-.001	(.001)				
Controls										
Promotion	2.135***	(.207)			2.134***	(.207)			2.181***	(.240)
CineClub	.814***	(.194)			.812***	(.193)			1.026***	(.203)
Domestic admissions			-2.3e-06***	(8.54e-07)			-2.3e-06***	(8.54e-07)		
Domestic awards	.609***	(.230)	-.487	(.706)	.613***	(.231)	-.487	(.706)	.745***	(.241)
New entrant	.029	(.051)	-.082	(.083)	.026	(.051)	-.082	(.083)	.061	(.050)
Production budget	-2.09e-04	(.006)	-.014*	(.007)	-2.5e-04	(.006)	-.014*	(.007)	.003	(.006)
Regional distributor	-.089	(.319)	-.494	(.337)	-.093	(.319)	-.494	(.337)	.121	(.319)
Int. Distributor	-.079	(.333)	-.305	(.380)	-.082	(.334)	-.305	(.380)	.107	(.334)
Family genre	.693***	(.181)	-.622**	(.316)	.691***	(.181)	-.622**	(.316)	.840***	(.184)
English	.906**	(.379)	-21.9***	(.547)	.910***	(.378)	-20.8***	(.547)	.977***	(.367)
No subsidy	-.227	(.266)	-.020	(.616)	-.224	(.268)	-.020	(.616)	-.141	(.301)
Art subsidy	.285	(.185)	-.825***	(.275)	.286	(.185)	-.825***	(.275)	.330*	(.197)
Constant	7.793***	(.490)	1.607***	(.409)	7.818***	(.490)	1.607***	(.409)	7.660***	(.457)
Number of obs.	2350				2350				1175	
Number of zeroes	649				649				0	
Log ps.likelihood	-22562.86				-22562.46				-14978.39	
Alpha	2.5e+08***				2.5e+08***					
Vuong	54.79***				54.81***					
Wald chi	349.50				352.54***				292.09***	

Standard error between parentheses. *p<0.10; **p<0.05; ***p<0.01significance levels at a one sided tests for key variables and two sided tests for control variables

3.5. Discussion

In the domestic market, part of the positive association between embeddedness and performance is caused by abilities developed through the collaboration network. The estimated models supported the hypothesis predicting a positive association between embeddedness and economic performance in the domestic market. From other studies we have seen that embeddedness increases performance levels due to improved opportunity recognition skills and increase in opportunity allocation (Sorenson and Waguespack, 2006; Stuart et al., 1999). In an attempt to control for allocation of opportunities this study include two indicators on opportunity allocation. As in Sorenson and Waguespack (2006) the promotion budget functions as a control for opportunity allocation. Furthermore models controls another type of opportunity allocation measured through inclusion in the Cinema Club. Claiming that the remaining estimated positive effect of embeddedness is exclusively caused by other mechanisms than opportunity allocation, would be stretching the results too far. However, I argue that part of the positive association between embeddedness and economic performance is due to development of abilities by accumulation of knowledge through network based collaboration. Highly embedded participants experience exposure to more knowledge and can accumulate knowledge faster. Furthermore, variations in quality of the exchanged knowledge may also be expected to vary with level of embeddedness so that well embedded participants have access to higher quality knowledge. Another mechanism which cannot be dismissed is the spread of private information through gossip. In small groups, gossip can be toxic, but in larger scale networks it functions as glue and transmit delicate information in an informal way (Shaw et al., 2010). As exposure to this private information increases with embeddedness, so does the ability to identify opportunities.

These mechanisms transforms into a "Matthew Effect"[14] of accumulated advantage (Barabasi and Albert, 1999; Merton, 1968a; Merton, 1968b).

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14 "For to all those who have, more will be given, and they will have an abundance; but from those who have nothing, even what they have will be taken away." Matthew 25:29,

Participants highly embedded in the collaboration network have higher opportunity recognition skills, higher probability of selection to high quality projects, and in the collaboration process, they are able to provide a more valuable contribution. Furthermore, their centrality in the collaboration network might result in favorable assessment of their contribution and, as a consequence, they are more likely to be associated with future high quality projects.

Neither in the domestic nor in foreign markets did the estimated models support the hypothesized decreasing benefits of embeddedness. However, as the analyses investigate the effects of participant's embeddedness in a project collaboration network, there are limits to the level of embeddedness. Individuals cannot participate in unlimited numbers of projects in the analyzed period. Therefore, it is plausible, that while costs continue to increase, the benefits of being embedded decreases after an unknown threshold which lays above the values observed in this analysis.

The third hypothesis predicted a negative association between embeddedness and economic performance on foreign markets. This was supported by the empirical findings. If we turn to the zero-inflation part of the models, we find a possible explanation for (part of) this negative effect. The association between embeddedness and selection for distribution in foreign markets is positive. This indicates a selection bias among gate keepers granting access to distribution on foreign markets, which benefits locally embedded project participants. As embeddedness of project participants influence gatekeeper's decision of which projects to grant resources to access foreign markets, we must assume that the level of quality varies between projects distributed on foreign markets, which are associated with highly and more weakly embedded project participants. Furthermore, from the association between embeddedness

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New Revised Standard Version. The concept entered sociology with Merton's paper from 1968 and was more recently revisited by Barabasi and Albert (1999).

and economic performance in the domestic market we also know that part of the benefit of being embedded lies in knowledge exchange. So, another potential explanation for why embeddedness does not benefit performance in foreign markets is that any localized quality of the knowledge exchanged through networks presents a problem for highly embedded project participants. When knowledge exchange suffers from network imposed blindness it only includes variations within the locally shared paradigms (Kuhn, 1962/1996).

The cause for over-embeddedness is two-fold: sup optimal allocation of scarce resources and localized abilities jointly produce a negative effect on performance in foreign markets. However, the association between embeddedness and total performance level is positive. Thus embeddedness is a profitable overall strategy for project participants seeking high economic performance. Being embedded is just not an effective strategy for performance in foreign markets. Furthermore, embeddedness is a poor strategy for gatekeepers' selection of how to allocate the scarce resources of distribution and promotion in foreign markets.

The reason why embeddedness becomes over-embeddedness lies in the nature of network generated benefits, which causes the cost-benefit trade-off to shift when participants enter foreign markets. The mechanism of opportunity allocation contributes to the creation of the negative association between embeddedness and economic performance in foreign markets. But so does the mechanism of knowledge exchange. Embeddedness is related to shared network paradigms and are therefore of little benefit in environments that do not place especial value on these specialized abilities. While the costs associated with being embedded stays constant, the benefits decrease with increased uncertainty. Selection bias allocating access to foreign markets to highly embedded participants rather than highly able participants, even creates a negative association between being embedded and economic performance in foreign markets. Participants with low levels of embeddedness in the collaboration network, however, are subject to a more severe scrutiny before

being launched on foreign markets. Only the very best projects by weakly embedded participants will be considered for the foreign market. This results in an above average performance. However, as the association between embeddedness and total economic performance remains positive, being embedded is still be worthwhile.

3.6. Robustness Check

One potential alternative explanation for the presented findings could be a "stardom effect" resulting in increased attention from the domestic audience towards films that include local industry stars. Similar effects have been found for other industries (Waguespack and Simcoe, 2010). Stars might be well embedded in the industry collaboration network. Therefore a positive correlation between stardom and embeddedness could be the underlying cause for the results presented in models 1-6. To control for such a stardom effect, I divided the population into groups based on their expected prominence to audiences: actors and directors are the most prominent stars, producers and screenwriters less prominent, and editors, composers and cinematographers the least known by audiences. Dummies for each group were interacted with our measure of embeddedness (and the dummy for market type). There were no significant effects of this measure indicating that the findings are not caused by a stardom effect. The estimated models are available from the author on request.

3.7. Conclusion

This paper challenged the predominant view of embeddedness and over-embeddedness as absolute and mutually exclusive terms which either increase or mitigate performance. The paper instead analyzed whether the optimal level of embeddedness depends on performance measure and tested this empirically through an analysis of the association between embeddedness and economic performance on the domestic and foreign markets. Comparing economic

performance in these distinct markets allowed investigation of the mechanisms behind the association between embeddedness and economic performance. The econometric analysis of data on the collaboration network of project participants engaged in sequential team production, revealed a positive association between embeddedness and economic performance in the domestic market, but a negative association between embeddedness and economic performance in foreign markets. The association between embeddedness and total economic performance is positive as is the association between embeddedness and selection for distribution on foreign markets. Combined these findings indicate, that the negative association between embeddedness and economic performance on foreign markets is partly caused by selection bias in access to foreign distribution and partly by localized value of knowledge accumulated through exchange. The implication of these findings is that embeddedness and over-embeddedness should not be viewed as absolute conditions, but rather as contingent on markets. Based on the results of this paper, it seems that for issues such as finding a job, getting a bonus, recognizing opportunities or landing those opportunities, participants need different types of embeddedness to improve their chances. Based on the analyses presented in this paper, I conclude that the value of embeddedness increases with predictability of a market. In uncertain markets, knowledge accumulation and especially accumulation of local knowledge is of little value.

This study only covers one national industry although it is an industry with collaborations across industry borders (e.g. with television, commercials, and theatre) and across national boundaries (e.g. with Hollywood, London and other Nordic countries). Peripheral participants in the analyzed network might be central within other networks and further research is required to understand cross fertilization between professional collaboration networks. In the paper, different types of participants are combined in one dataset. Further research might provide some insights by analyzing network effects separately for different roles in the production process.

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CHAPTER 4

ORACLE OR OBSTACLE? INDIVIDUAL LEVEL KNOWLEDGE HETEROGENEITY AND SUCCESSFUL INNOVATION

by

Kristina Vaarst Andersen

Abstract

Project participants endowed with knowledge heterogeneity are more likely to contribute with diverse perspectives to team production. They are therefore more likely to be associated with successful innovative projects. Projects that aim for variety rather than novelty may, however, see coordination and communication costs associated with the inclusion of an individual with higher knowledge heterogeneity overturn the benefits. I test these propositions using data that allows for isolation of the effects of individuals' knowledge heterogeneity by exploiting temporary labor mobility between projects across country borders. I find support for the hypothesis that project participants endowed with knowledge heterogeneity are more likely to be associated with successful innovation projects. Furthermore, this association is moderated by the innovative aim of the focal project. The probability of association with a successful innovation project increases for individuals participating in projects aiming for creation of novelty, and decreases for individuals associated with projects aiming for variety based on incremental modifications of a predefined formula.

4.1. Introduction

Many mechanisms favor emergence of innovations from the combination of different but complementary perspectives. Knowledge heterogeneity ensures diverse perspectives and thus increases the potential for successful problem solving and innovation (Galunic and Rodan, 1998; Hong and Page, 2001; Nelson and Winter, 1982; Page, 2007; Schumpeter, 1934; Sosa, 2011). Individuals can acquire knowledge heterogeneity through participation in foreign projects. Through collaboration in foreign settings individual project participants absorb foreign perspectives and integrate them into their general knowledge framework. Knowledge heterogeneity enhance learning abilities (Reagans and Zuckerman, 2001), and diversity of perspectives provides the project participant with a better toolbox for finding optimal solutions to difficult problems (Hong and Page, 2001; Page, 2007). Thus we should expect individuals with heterogeneous knowledge to be the 'oracles' in project-based innovation. However, diverse perspectives also increase transaction costs within the collaborating team and impose opportunity costs on the individual. Consequently, inclusion of individuals endowed with heterogeneous knowledge in projects presents a tradeoff of costs and benefits.

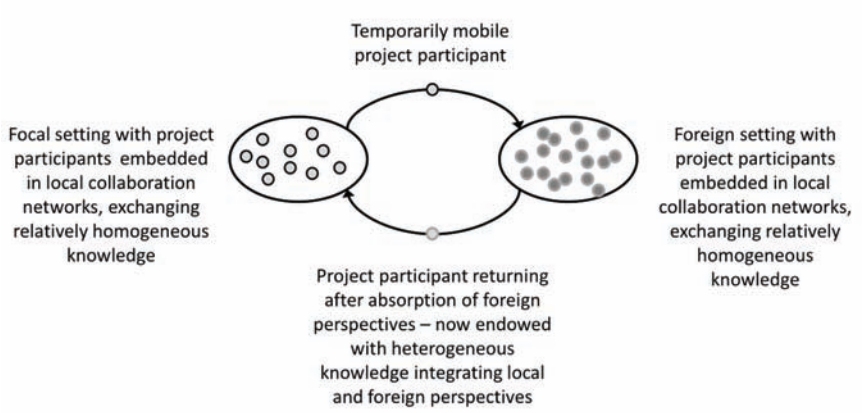
A substantial body of research advocates the benefits of knowledge heterogeneity for innovation at organizational (Chesbrough, 2003; Laursen and Salter, 2004, 2006; Reichstein and Salter, 2006; Reichstein et al., 2008) and team level (Bercovitz and Feldman, 2011; Delmestri, 2005; Usai, 2001; Uzzi and Spiro, 2005). Research points to individual relations as the root of inter-regional and inter-firm knowledge exchange (Singh, 2005), and several studies highlight the individual level benefits of far-reaching networks delivering heterogeneous knowledge (Beckman et al., 2004; Burt, 1992, 2004; Granovetter, 1973). Labor mobility is one way to establish such individual level linkages. Labor mobility directly transfers knowledge from one employer to the next. Other, indirect, effects are increased allocation of attention between the involved employers and establishment of informal communication channels (Corredoira and Rosenkopf, 2010; Rosenkopf and Almeida, 2003; Rosenkopf and Nerkar, 2001). These mechanisms are all at the individual level, though they benefit organizations and regions, but few studies investigate the

individual level benefits of knowledge heterogeneity (see Burt, 2004; Rodan and Galunic, 2004, and Hong and Page 2001 for exceptions).

At the individual level, knowledge heterogeneity presents a trade-off between innovative potential and specialization. The innovative potential follows from the diversity of perspectives enabling the project participant to identify optimal solutions to a wide range of problems (Hong and Page, 2001; Page, 2007). However, to acquire this diversity of perspectives, project participants must allocate valuable time to foreign projects and forego local projects which would increase accumulation of homogeneous context specific knowledge. This results in less context specific specialization and increases communication and coordination costs of interactions with peers in possession of more homogeneous pools of knowledge (Reagans and Zuckerman, 2001). Knowledge heterogeneity thus decreases specialization and impose transaction costs ---characteristics which are normally negatively associated with performance (Bercovitz and Feldman, 2011; Delmestri, 2005).

The paper addresses the question of whether individuals with heterogeneous knowledge have a higher probability of being associated with successful innovation projects. Knowledge heterogeneity is acquired through individual level temporary mobility. Mobility events are defined as participation in projects outside the focal region. The process is illustrated in figure 4.1. Mobile project participants are matched with a control sample of immobile project participants similar on essential dimensions. This setup allows us to ask how the individuals endowed with knowledge heterogeneity would perform without it. The paper investigates whether individual's endowed with knowledge heterogeneity are more likely to be associated with successful innovation projects suggesting that they contribute to the success. The aim is hence to establish if these individuals can be considered the oracles of the industry, or if their foreign perspectives obstruct project collaboration.

FIGURE 4.1.
Access to foreign perspectives through labor mobility.



I analyze this association between knowledge heterogeneity, probability of successful innovation, and the potentially moderating effect of the innovation level, using data from the Danish film industry, which includes information on all feature films (hereafter films) released between 1995 and 2008, and the individuals participating in them. As films are predominantly produced by one-off teams of freelancers, the film industry (like many other creative industries) is an optimal setting for studying individual level knowledge exchange through networks (Christopherson and Storper, 1986; Grabher, 2002b). The more talented individuals receive the most offers, but due to ex ante and ex post uncertainty, it is impossible perfectly to predict which projects will succeed (Caves, 2003; Elberse, 2007; Ferrari, 2007; Litman, 1983; Ravid, 1999; Sorenson and Waguespack, 2006). Within teams each individual addresses a specific function or functions matched to their skills. Some individuals participate in projects outside of the focal setting and are thus exposed to foreign perspectives, which increase their knowledge heterogeneity. Freelancers move back and forth between projects and regions and through this mobility they acquire and integrate different perspectives and mentally bridge cognitive distance.

Within the film industry, the result of the production process is not a technological but rather a stylistic innovation. Stylistic innovations are the creation of novel aesthetic expressions through re-combinations of existing knowledge (Caves, 2003; Tran, 2009). In this context, foreign perspectives could relate to different experiences with ways to bring about moods and sentiments or to communicate impressions and insinuations to the audience. The dependent variable introduced as a proxy for successful innovation is nomination for international festivals and Oscar awards. The number of nominations varies across years and since nomination for non-domestic awards takes place in international competition, the restricted variation on this dependent variable is not a problem. As no individual-film combination received more than one foreign nomination, we can explore the association between knowledge heterogeneity and foreign nominations through a logit model. I find that project participants endowed with knowledge heterogeneity are more likely to be associated with successful innovation projects. However, this association in not merely mitigated for individuals associate with projects aimed for variety based on incremental modifications to a predefined formula, it is reversed.

The paper is organized as follows: Section 4.2. introduces the theoretical framework for the association between knowledge heterogeneity and innovation. The data and empirical methods for exploring the hypotheses are described in section 4.3. Section 4.4. presents the results of the analysis, and these are discussed in section 4.5. Section 4.6. concludes the paper.

4.2. Theoretical Background

Knowledge heterogeneity increases the potential for innovation, while proximity mitigates difference in perspectives but increases probability of smooth project collaboration. The relationship between knowledge heterogeneity and innovation is thoroughly researched for regions, firms, and

teams. Innovative performance is measured as successful commercialization (Bercovitz and Feldman, 2011), degree of innovativeness (Dewar and Dutton, 1986; Ettlie, 1983; Ettlie et al., 1984), and expert assessments (Baker and Faulkner, 1991; Delmestri, 2005; Faulkner and Anderson, 1987). Regardless of the measure used, two contradictory features improve the probabilities of success when organizing for innovation. These are proximity and heterogeneity. Often proximity is measured as geographical proximity, but co-location is not sufficient to increase success rates. Geographical co-location impacts on innovation through facilitation of social, institutional, cognitive and organizational proximity (Boschma, 2005). In this paper, the discussion centers on geographical, social, and cognitive proximity. One effect of geographical proximity is the positive externalities facilitated by local social networks developed through mechanisms such as local labor mobility (Almeida and Kogut, 1999), socialization (Dimaggio and Powell, 1983), and local 'buzz' (Gertler, 1995, 2003; Saxenian, 1994; Storper and Venables, 2004). Within regions, interaction at the individual level is frequent due to geographical proximity. The result is high levels of social proximity, and subsequently cognitive proximity in form of shared and closely related knowledge bases (Boschma, 2005). This high level of overall proximity facilitates easy knowledge exchange and rapid acknowledgement of value. However, strong embeddedness can also lead to lock-in situations of over-embeddedness. Over-embeddedness results in knowledge homogeneity, which mitigates the potential for innovation through recombination (Chesbrough, 2003; Galunic and Rodan, 1998; Masciarelli et al., 2010; Nerkar, 2003; Owen-Smith and Powell, 2004; Rodan and Galunic, 2004).

The diversity/proximity trade-off has been formalized within economic theory. Under specific conditions including facing difficult problems and supply of large pools of problem solving agents, diversity of perspectives among problem solving agents has proven an effective tool for identifying optimal solutions (Hong and Page, 2001). The functional diversity of perspectives is strongly related to identity diversity. Because geographical proximity leads to other types of proximity it reduces identity diversity and consequently diversity of perspectives (Hong and Page, 2001; Page, 2007). For regions, firms, and

teams aiming for high levels of innovation, this is problematic. One solution to this problem is to access foreign perspectives. However, this in turn leads to problems of assessment, absorption, and integration.

Theories about how to achieve an optimal mix of familiarity and foreignness have been developed in two streams of the literature. The economic geography literature argues that knowledge transfer through strategic, firm level pipelines can provide access to foreign perspectives, which prevent over-embeddedness (Agrawal et al., 2006; Bathelt et al., 2004; Faulconbridge, 2006; Maskell et al., 2006). The mechanisms proposed for interregional knowledge exchange are firm level alliances and joint ventures. However, this literature does not address the process of initial tie formation, attention allocation, and ability to recognize the value of knowledge. These aspects are addressed in the strategic management literature on knowledge spill-over among firms. Here individual level labor mobility between a focal firm and a new employer is seen as linkages increasing probability of attention allocation and acknowledgement of the value of foreign perspectives (Almeida and Kogut, 1999; Corredoira and Rosenkopf, 2010; Rosenkopf and Almeida, 2003; Rosenkopf and Nerkar, 2001). These mobility events ensure knowledge heterogeneity for the focal organization and thereby facilitate higher levels of innovative performance. Temporary mobility to a foreign production site facilitates absorption of foreign perspectives, which leads to individual level knowledge heterogeneity. In this study, temporary mobility events are project specific. When project participant subsequently return to their focal region with the absorbed foreign perspectives they are expected to be better able to recognize and contribute to potentially successful projects (Burt, 2004).

Heterogeneous Knowledge, Proximity, and Innovation

The availability of heterogeneous knowledge increases the probability of innovation, but for foreign perspectives to be absorbed some element of proximity is necessary. Several types of proximity (Boschma, 2005) ease collaboration and increase probability for knowledge absorption. However,

diversity (which could also be labeled distance) is what facilitates development of different perspectives. Though diversity creates difficulties for collaboration, it also enhances learning and increases probability of finding optimal solution to difficult problems (Hong and Page, 2001; Page, 2007; Reagans and Zuckerman, 2001). The challenge is to find the optimal mix of similarity and diversity. In management studies, mobile employees are found to combine proximity and diversity. (Corredoira and Rosenkopf, 2010; Rosenkopf and Almeida, 2003). As they move between firms, they change from one setting to another and establish a linkage for knowledge exchange. The mechanisms described in these studies refer to individual level processes and are similar to those emphasized in the sociological literature on interpersonal networks (Burt, 2004; Franzen and Hangartner, 2006; Granovetter, 1973; Ingram and Roberts, 2000; Uzzi and Spiro, 2005). Within the literature on regional innovation, individuals have primarily been argues to create local buzz through informal ties between co-located individuals (Gertler, 1995, 2003; Storper and Venables, 2004). But individuals have also been acknowledged as potential agents for interregional knowledge exchange (Agrawal et al., 2006).

Some tacit elements of knowledge are often necessary to reach innovative results, and labor mobility is one way to exchange tacit knowledge and frameworks for future knowledge exchange. Exchange of such tacit knowledge is best facilitated through networks (Sorenson et al., 2006) and face-to-face collaboration (Håkanson, 2000). Knowledge exchange is more likely to lead to successful performance if sender and recipient are proximate on some dimensions, although still distant enough on other dimensions for the exchanged knowledge to add diversity to each party's existing knowledge pool (Pond et al., 2007). Labor mobility provides and often presupposes social ties, which provide the element of proximity. Several mechanisms are at play. First, the mobility event itself increases the attention allocation between employers. This leads to increased interest in previous work, perspectives, and techniques characterizing the prior/future employer of the mobile employee (Corredoira and Rosenkopf, 2010). Second, due to diverse knowledge bases, mobile individuals more readily acknowledge the value of foreign perspectives (Corredoira and Rosenkopf, 2010; Gregoire et al., 2010). This leads to quicker

absorption and integration of foreign perspectives. Third, foreign linkages increase access to foreign knowledge, and especially to private information (often in the form of gossip) on potential opportunities and issues that increase the likelihood of avoiding pit-falls and reaching good ideas (Burt, 1992, 2004; Sorenson and Stuart, 2008; Sorenson and Waguespack, 2006). These three mechanisms of attention allocation, acknowledgement of foreign perspectives, and access to private information result in mobile individuals developing heterogeneous knowledge, and thus lead to higher levels of creativity at the project level, which results in innovative final products.

This paper argues that the establishment of linkages to foreign settings and especially the mobility event of collaboration in foreign settings, positions individuals favorably to be associated with successful innovation projects. The positive association is caused by the mobile project participant acquiring foreign perspectives through mobility events, which endows him or her with a more heterogeneous knowledge portfolio. This proposed association between foreign linkages, knowledge heterogeneity, and successful innovation leads to the first hypothesis:

Hypothesis 1: A project participant's probability of engaging in successful innovation projects is positively associated with his/her level of knowledge heterogeneity.

Types of Innovation and the Value of Knowledge Heterogeneity

The literature provides several distinctions between types of innovation, the most common one being radical versus incremental innovation (Dewar and Dutton, 1986; Ettlie, 1983; Ettlie et al., 1984). In the context of stylistic innovation, the distinction between types of innovation is no less important than in studies addressing technological innovations. Stylistic innovation is about the creation of novel aesthetic and symbolic expressions produced for the market (Baker and Faulkner, 1991; Delmestri, 2005; Faulkner and Anderson, 1987; Tran, 2009). Stylistic elements play an increasing role in creating competitive advantage for products generally (Pine and Gilmore,

1999) and is the primary focus for the creative industries (Caves, 2003). Theory on product development within creative industries argues that all cultural products are essentially innovations since each product is a unique recombination of (mostly pre-existing) elements of knowledge (Baker and Faulkner, 1991; Caves, 2003; Delmestri, 2005; Faulkner and Anderson, 1987). But clearly, not all cultural products are equally innovative. Within the research on creative industries, this variation in the degree of innovation is captured by the distinction between the development of a creative product based on prefabricated scripts with a few elements of variation, and the development of novel creative products encompassing complex recombinations of many elements of knowledge (Lorenzen and Frederiksen, 2008). This distinction is described as innovation through variety versus innovation through novelty creation. It corresponds approximately to the distinction between incremental and more radical innovation in the traditional innovation literature.

The tradeoff between knowledge heterogeneity and transaction costs depends on innovation type. Innovation through both variety and novelty creation presupposes a pool of relevant knowledge elements that can be recombined. Thus both types of innovation benefit from project participants with foreign perspectives. On the level of the team, Bercovitz and Feldman (2011) find that knowledge heterogeneity mostly benefits teams engaged in novelty creation. Individuals with different perspectives are essential for locating optimal solutions to difficult problems, but matter less for solving trivial ones (Hong and Page, 2001; Page, 2007). Project participants engaged in novelty creation face more difficult problems than do participants in projects aiming for innovation through variety, and thus the value of knowledge heterogeneity differ with innovation type. Furthermore, efficiency often comes with costs for the innovative process (Delmestri, 2005). Efficiency grows from stability and routinization, which facilitates successful operation, but stability and well known routines can be obstacles to innovation (Delmestri, 2005; Galunic and Rodan, 1998). Divergent perspectives can disrupt routines and add to coordination and communication costs of team collaboration (Bercovitz and Feldman, 2011). As innovations through variety and novelty have different requirements for foreign perspectives, the tradeoff between the burden of

bridging cognitive distance and the benefit of knowledge heterogeneity might reasonably be expected to differ between innovation by variation and innovation through novelty creation. This leads to hypothesis two:

Hypothesis 2: Project participants engaged in projects aimed at creating variety rather than novelty will experience lower positive association between knowledge heterogeneity and affiliation with successful projects.

4.3. Data and Methods

The hypotheses are tested with data from the Danish film industry. The cultural industries show a higher degree of clustering than other knowledge intensive industries due to the industry structure in which many freelancers shift between projects (Grabher, 2002a; Lorenzen and Frederiksen, 2008; Malmberg and Power, 2005). This liquid industry structure provides a framework for the continuous innovation enforced by short product life cycles and consumer demand for newness (Caves, 2003). It also provides an interesting setting for studying labor mobility. Professionals from the Danish film industry often participate in film projects based in other regions and are thereby exposed to foreign perspectives. This set up allows for comparing the probability of being affiliated with successful innovation projects for project participants with and without heterogeneous knowledge.

Data

I constructed an individual level database by combining publicly available data and non-public data from the Danish Film Institute with data available on official festival web sites and at IMDb.com. This combination allows for an analysis of the associations between individual level acquisition of foreign perspectives and participation in high performing projects. Several researchers utilize collaboration data from creative industries (especially the film industry) to analyze network effects in settings demanding high rates of new product

development and novelty creation (Cattani and Ferriani, 2008; Cattani et al., 2008; Delmestri, 2005; Ferriani et al., 2009; Grabher, 2002a, b; Lorenzen and Taube, 2008; Sorenson and Waguespack, 2006; Tran, 2009; Usai, 2001; Uzzi, 1997; Uzzi and Spiro, 2005). The project based organization, and repeated changes of collaboration partners provide optimal opportunities for studying collaboration networks and outcomes (Faulkner and Anderson, 1987). An actual collaboration is seen as the consolidation of a preexisting social tie. Other, more informal ties might provide similar benefits, but the acquisition and integration of knowledge is enforced through collaboration. Collaboration thus serves as a lower bound for interpersonal relations (Singh 2005). In other studies, collaborations are studied primarily at firm or project level. In the present study, however, the focus is on project participants who collaborate to create novel stylistic expressions. This focus was chosen to analyze the individual level incentives for achieving knowledge heterogeneity. The Danish film industry is an ideal setting for studying this. Danish films have received increasing international recognition since 1990 culminating with Danish Director Susanne Bier winning both a Golden Globe and an Oscar award for the best foreign language feature film in 2011. The industry is highly subsidized and has a clear art film focus; with only 25-30 feature films produced a year, the industry is quite small which leads to frequent repeated collaborations and high internal clustering. Project participants who exclusively collaborate within in the national industry network run the risk of developing highly localized and homogeneous knowledge and perspectives. Thus, the association between participation in foreign projects and innovation adds to our understanding of the relationship between knowledge heterogeneity and professionals' affiliation with successful innovation projects.

The data cover all Danish films released between 1995 and 2008. Films are defined as Danish, based on the nationality of the production company (including cross country collaborations with substantial Danish participation). The cast and crew may be international, the language of the film need not be Danish, and the financing can come from private investors and film funds across the world. All professionals holding any of the roles of actor (limited to the five leading actors), director, producer, screenwriter, cinematographer,

composer, or editor in the production process are included in the analysis. These freelancers work on shifting projects and thus over time become embedded in collaboration networks which convey information and resources necessary for the successful execution of such projects (Ferriani et al., 2009). Within the Danish film industry, projects are generally initiated by a director or jointly by a director and producer, and are based either on a vision held by the director or existing material which a screenwriter is hired to adapt to a film script. After this initial phase, actors, cinematographers, composers, and editors are hired to work with the core team on production and post production.

Danish film production is heavily subsidized by the Danish state through the Danish Film Institute (DFI): 98.2% of all Danish films produced in the analyzed period are subsidized under DFI's artistic subsidy program (58.6%, DFI consultants assess the artistic value of ideas for feature films without considering budgetary aspects and, if subsidy is granted, the consultant participates with expert advice in the further development of the film) or DFI's commercial program (39.6%, based on assessment of the film's potential revenue). Thus, the artistic focus of the cluster is substantial and the level of stylistic innovation is generally high, with most productions being based on original material and few being sequels. One exception is the genre of children's and family films which have a sequels rate of 34.3% (all other genres combined have a sequels rate of 3.9%), and a high degree of recycling of old material and characters (some of the most popular children's and family films released in the period are remakes (and remakes of sequels) based on ideas developed in the 1950s and 1970s). This genre tends to focus on incremental innovation through variety rather than the novelty creation that otherwise is predominant in the industry.

Most data are gathered from the Danish Film Institute archives. As all production companies and distributors are legally obligated to report to the Danish Film Institute, these data are reliable and few productions are omitted (collections of short films are removed from the sample and 71 observations

were excluded from the sample due to lack of budget data). Foreign project participants are excluded from the analyses to avoid bias. Data on admissions are collected by theaters' reporting to Statistics Denmark. The local industry network position is calculated (in UCInet) based on archival records of collaboration. The first five years (1995-1999) are used to create a basic industry network. Thereafter, network measures are based on a five-year rolling window with a one-year time-lag: the level of embeddedness in year x is assumed to be related to selection into projects in year x+1. Foreign linkages are identified by extracting information from IMDb.com and resumes for each project participant (December 2010-January 2011). No time dimension is added to recording of foreign linkages because collaboration events are perceived as realizations of pre-existing interpersonal ties.

Dependent Variable

The dependent variable for the analyses is association with successful innovation projects, measured as projects nominated for awards or invited for inclusion at selected international festivals (for simplicity both are referred to as nominations). The nominations selected are to the American Academy of Motion Picture Arts and Sciences awards (Oscar), Sundance Film Festival, Cannes Film Festival, Berlin Film Festival, and Amsterdam Film Festival. The reasons for choosing nominations are multiple. First, previous research shows that nominations, rather than awards obtained, are the distinctive factor for commercial success and recognition (Dodds and Holbrook, 1988). Second, the number of awards is (virtually) fixed each year regardless of the innovativeness of the films released, but the number of nominations varies somewhat according to the quality of the stylistic innovation. Choosing foreign nominations further reduces this issue, as Danish films are in international competition. Third, foreign nominations of Danish films for the selected awards and festivals are rare and indicate acknowledgement of a high level of stylistic innovation by international industry experts.

A successful project is the result of a complex process combining many skills and inputs. Positive outcomes of the dependent variables are indicators of the combined effects of the project participant's selection and contribute to successful stylistic innovation projects. Nomination for foreign awards is positively correlated (at the 0.05 significance level) with receipt of a foreign award (0.5701), domestic nominations (0.2624), domestic awards (0.1929), and theater audience numbers (0.0466).

Key Variables

Knowledge heterogeneity: The national collaboration network is well integrated and is centered around the city of Copenhagen. Foreign linkages are defined as collaboration on projects located outside of Denmark (the focal region). A high concentration of industry activity within specific regions in different nations is to be expected since previous research shows that there is a tendency towards high levels of clustering in the creative industries (Lorenzen and Frederiksen, 2008; Malmberg and Power, 2005). However, as actual shooting of films is often located to exploit opportunities for local subsidies or specific settings, the geographical boundaries of individual regions within countries are blurred. There is also a practical obstacle to identifying regional level linkages as data lacks details on localities within countries. Foreign linkages are measured as participation in film projects located in other countries. The process allows for assessment of the reported collaborations, consequently some reported participations in foreign projects are deemed too insignificant to be recorded as a foreign linkage. For instance, if a foreign production is a coproduction in which the only foreign element is financing and/or location, no foreign linkage is recorded. Similarly no foreign linkage is recorded if the role undertaken by the project participants is very minor --- for instance "end credits editing."

For robustness checks of the key models, the variable is divided into Knowledge Heterogeneity (Non-Scand) and Knowledge Heterogeneity (Scand) denoting knowledge heterogeneity acquired through foreign linkages to non-Scandinavian versus Scandinavian countries.

Low level innovation: The innovation level within the children/family segment is substantially lower than for the remaining industry. This segment aims for variety rather than novelty. The sequel rate is ten times higher and most projects are based on preexisting material (books, television shows, fairytales etc.). Several of the most popular Danish children's/family productions are remakes of old Danish children/family productions in series of sequels. Diverse perspectives are hypothesized to be less strongly associated with affiliation with successful innovation projects.

Controls

Network position: The literature on regional spill-over effects and several studies on the film industry find effects of local network position (Cattani and Ferriani, 2008; Delmestri, 2005; Ferriani et al., 2009; Grabher, 2002b; Lorenzen and Taube, 2008; Pontikes et al., 2010; Sorenson and Waguespack, 2006; Usai, 2001). A quantified measure of each individual's position in the collaboration network in each year of observation is therefore included in the model. A tie is defined as collaboration on a film project. In creative production, knowledge is primarily exchanged through first-hand interaction and observation within project collaboration, and therefore increasing path length decreases the probability of knowledge exchange (Uzzi and Spiro, 2005). As the size of an agent's network grows, the probability of acquiring knowledge or mobilizing resources decreases, with increasing path length (Lin, 2001; Wasserman and Faust, 1994/1997). To capture this important aspect of the benefits of local industry network position, I calculate it as the normalized eigenvector closeness centrality (for another example of this application see Ferriani et al., 2009). The normalized eigenvector closeness centrality measure is based on each project participant's closeness to all other network members. For the network (adjacency matrix) A, the eigenvector centrality of participant i (ci) the eigenvector closeness centrality measure is calculated by the algorithm:

$$c_i = \alpha \sum A_{ij} c_j$$

where α is a parameter with reciprocal eigenvector value. The eigenvector centrality of each participant therefore depends on the eigenvector centrality of

its linked participants (cj). Both the size of the ego's network as well as the quality and reachability of the connections are included in the measure. Normalized eigenvector centrality is the scaled eigenvector centrality divided by the maximum difference possible, expressed as a percentage. The eigenvector measure is calculated in the UCInet social network analysis program (Borgatti, 2002).

New entrant: Project participants new to the industry might receive disproportionate attention from critics and media (Cattani et al., 2008). Especially if they enter from a related industry (e.g. theater). To account for this possible effect I created a dummy variable NewEntrant, which indicates entry in the year of observation.

Production budget: Availability of resources is likely to affect the quality of the film. Production budget data are available for the majority of films released in the analyzed period and are included in the analyses to control for available resources. This excludes around 5% of total observations from the analysis due to missing data. Among the productions not reporting budget figures there is an over-representation of films produced without Danish Film Institute subsidy. Thus, the choice to include budget data in the models creates sample bias, but this is preferable to relying on fictive estimated production budget figures based on previous performance (see Sorenson and Waguespack (2006) for a previous example of this approach).

Artistic subsidy: Few agents are involved in films produced without any kind of subsidy, and most participate in projects subsidized by the Danish Film Institute, with grants based on artistic merit (perceived by DFI consultants), or commercial potential (based on budget predictions and predicted revenue). The type of subsidy indicates the type of project. Subsidy is granted relatively early in the development process, and thus not all films that are given a subsidy are realized and far from all assumptions about creative value or potential revenue hold true. However, the type of subsidy received is an indication of the original intent of the film project in which the agent participated. This applies especially to participation in projects financed by artistic subsidy since this type of grant is awarded based on an assessment of the stylistic innovativeness and artistic potential of the idea behind the film. I include a dummy for participation in productions receiving artistic subsidy.

English: When agents participate in film projects where English is the main language, the aim is most often international recognition of the final product. Individuals participating in mainly English language film projects should have higher probability of acknowledgement of the film outside of the local context; I therefore include a dummy for English.

Sequel: Following the examples of other researchers (Cattani et al., 2008; Ferriani et al., 2009; Ravid, 1999) the variable Sequel indicates whether an agent participated in an original film or a sequel. Sequels have the possibility to capitalize on the interest created by the original/previous film. However, on average sequels tend to have higher costs and earn less than the original films.

Type of distributor: The type of distributor could influence the agent's performance because majors are able to offer more resources (monetary) and higher quality resources (professional skills) (Ferriani et al., 2009; Litman, 1983). The types of distribution companies identified are: national companies, regional Scandinavian/Nordic companies, and international companies (including companies in exclusive alliance with international companies). The effect of association with regional and international distributors should be most evident for nominations for non-local awards; therefore I include dummies for regional distributor and international distributor in the models.

Year and period: Due to the dependence of the Danish film industry on state subsidies, I include dummies, which distinguishes between periods with different negotiated terms for subsidy. Year dummies are included to control for variations in the industry and trends in demand and popularity (Ferriani et al., 2009).

Matching Procedure

There might be differences between project participants who pursue foreign linkages and professionals who do not receive or accept offers to connect internationally. Those that make foreign linkages might reasonably be assumed to be more explorative and thus more likely to be involved in projects that are innovative and receive nominations. There might also be differences based on

the project participant's position in the local industry network, with the central stars receiving more invitations to join foreign projects. Also, successful project participants might receive more invitations to collaborate on foreign projects. Different types of professionals with different roles in the production process might experience different obstacles, opportunities, costs, and pay-offs from foreign collaboration. Finally, the increasing internationalization of the Danish film industry might be lowering the barriers to participation in foreign projects.

To address these issues, I apply a combination of exact matching and propensity score matching on the variables that may reasonably be assumed to affect the probability of forming foreign linkages, to create a control sample of comparable individuals without foreign linkages. (Rosenbaum and Rubin, 1983, 1985). This matching procedure allows for investigation of the relationship between knowledge heterogeneity and probability of being associated with a successful innovation project, given the conditional probability of forming foreign linkages and thus acquiring the foreign perspective resulting in heterogeneous knowledge

In the propensity score matching procedure, I include the structural position in the local collaboration network (Network position). I also match on project participant's average commercial success in the domestic and foreign markets. These variables are labeled Ave.dom.rev. and Ave.for.rev respectively. Commercial success is likely to increase probability of professionals being recruited for foreign projects and therefore to increase the probability of forming foreign linkages. Generally, successful performance will increase perceived value for potential foreign collaborators, and participation in domestic productions that succeed in foreign markets is good marketing for individuals. I also matched all observations on two exact criteria. Participation in projects released within certain time periods is an exact match variable, since the industry shows a tendency of increasing internationalization. I distinguish between the three periods described in the overview of variables. The type of role in the production is an exact match variable as different roles have

different levels of public visibility and different career paths. I distinguish between front roles (directors, producers, and actors) and back stage roles (editors, composers, screenwriters, and cinematographers).

Due to the limited pool of available untreated matches, some matched observations are used multiple times; potential bias is corrected for by employing cluster correction effects in the estimations. Analysis of the matched observations shows no significant differences between treated and untreated observations on the matching variables. The estimated model has a very low chi square value suggesting practically no model validity and a very low R-square indicating practically no explanatory power (see appendix I). Thus the results presented in the tables are for comparable samples of observations endowed with heterogeneous knowledge and without.

The Model

The purpose of this study is to analyze the relationship between knowledge heterogeneity and association with successful innovation projects given differences in project level innovative aim. In order to do that, I conduct an individual level study to explain the probability of a given participant being associated with a project nominated for an international award. I use a dummy variable for project participants with heterogeneous knowledge, a dummy for participation in projects aimed at creation of variety rather than novelty, and the interaction between these two dummies. I test the robustness of the results by varying the measure of individual level knowledge heterogeneity. The data are organized at the individual level and each individual-film combination is one observation. To compare the association between knowledge heterogeneity and successful innovation for participation in projects aimed at different levels of innovativeness, I interact the knowledge heterogeneity dummy with the dummy for participation in low innovation productions. The model can be written as:

$$Pr(\text{participation in successful innovation}=1 \mid ki, l, k*l, c, \beta)$$

where the probability of participation in an acknowledged successful stylistic innovation depends on a dummy for knowledge heterogeneity labeled *k*, a dummy for participation in low innovation productions labeled *l*, and a vector of the control variables labeled *c*. A binary dependent variable dictates either a probit or logit model specification. I find no overall difference in results using one or the other. I here present the logit results. Since co-variation is common across projects I control for clusters by project title. All the estimations considered are robust using a Huber-White-sandwich technique for heteroskedasticity correction. All models are estimated using the matched sample.

4.4. RESULTS

Descriptive statistics and the correlation matrix are presented in table 4.1. The low levels of correlation between the independent variables do not suggest issues of multicollinearity. This is supported by low estimates of variance inflation factors. Table 4.2. presents the estimated models. I apply a hierarchical approach. Model 1 only includes controls, model 2 includes main effects of the explanatory variables, and model 3 includes the interaction term. Models 4-7 are robustness checks.

Hypothesis 1 proposes that individuals endowed with knowledge heterogeneity are more likely to be associated with successful innovation project. This relationship is tested directly in model 2. Counter to the proposed hypotheses, there seems to be no significant association between knowledge heterogeneity and affiliation with successful innovative projects. However, recall that all types of innovation projects are analyzed together in this model regardless of the level of innovation. The estimated effect for participation in a low level innovation is significantly positive suggesting an over representation.

TABLE 4.1.

Descriptive statistics and correlation matrix for dependent, key and control variables for 1860 matched observations

Variable	Mean	Std. Dev.	1	2	3	4	5	6	7	8	9	10
1. Successful innovation	.202	.402										
2. Knowledge heterogeneity	.5	.500	.040									
3. Knowledge heterogeneity (Non-Scandi)	.395	.489	.048	.808								
4. Low level innovation	.279	.449	.084	-.191	-.172							
5. Network position	3.869	8.452	-.058	-.011	.021	.037						
6. New entrant	.294	.456	-.013	-.126	-.107	-.002	-.296					
7. Production budget	18639	15026	-.025	.036	.079	.007	-.027	-.016				
8. Artistic subsidy	.604	.489	.281	.123	.119	-.242	-.1390	.028	-.005			
9. English	.048	.215	.043	.015	.048	-.034	-.093	.069	.579	.121		
10. Sequel	.119	.324	-.135	-.121	-.090	.461	-.034	-.015	-.055	-.379		
11. Scand. distributor	.603	.490	.163	.071	.081	.015	.101	-.050	-.103	.058	-.035	
12. Int. distributor	.239	.426	-.075	-.096	-.081	.118	-.089	.048	-.077	-.073	.176	-.690

Periode dummies and year dummies excluded, *indicates 0.1 significance level. All correlation estimates above 0.45 og below -0.45 are significant at a 5% level
**indicates 0.05 significance level, ***indicates 0.01 significance level

TABLE 4.2.
Association with Successful Innovation Project. Results of Logit Regressions

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Knowledge heterogeneity		.0881	.5704**				
		(.2191)	(.2816)				
Knowledge heterogeneity (Non-Scand.)				.1419	.6824**		
				(.2303)	(.2790)		
Knowledge heterogeneity (Scand.)						.1089	.3447
						(.1926)	(.2131)
Low level innovation		.9632*	1.771***	.9765*	1.773***	.9617*	1.300**
		(.5243)	(.5767)	(.5248)	(.5469)	(.5241)	(.5708)
Knowledge het.* Low level innov.			-1.707***		-2.391***		-1.030***
			(.3624)		(.4003)		(.3745)
Network position	.0050	.0039	.0004	.0034	.0002	.0046	.0041
	(.0171)	(.0162)	(.0158)	(.0162)	(.0157)	(.0166)	(.0164)
New entrant	-.2820	-.2771	-.2271	-.2719	-.2039	-.2732	-.2621
	(.2725)	(.2784)	(.2745)	(.2768)	(.2756)	(.2757)	(.2733)
Prod. budget	-1.29e^{-05}	-1.75e^{-05}	-1.65e^{-05}	-1.78e^{-05}	-1.64e^{-05}	-1.74e^{-05}	-1.71e^{-05}
	(2.08e^{-05})	(2.36e^{-05})	(.238e^{-05})	(2.35e^{-05})	(2.33e^{-05})	(2.35e^{-05})	(2.38e^{-05})
Artistic subsidy	1.690**	1.787***	1.881***	1.783***	1.892***	1.788***	1.837***
	(.6747)	(.6317)	(.6256)	(.6309)	(.6188)	(.6314)	(.6246)
English language	-.3399	-.1166	-.1501	-.1259	-2202	-.1131	-.1193
	(1.123)	(1.274)	(1.268)	(1.270)	(1.256)	(1.274)	(1.273)
Sequel	-.6626	-.9834	-1.156	-.9914	-1.211	-.9743	-1.014
	(1.186)	(1.109)	(1.119)	(1.115)	(1.066)	(1.108)	(1.123)
Scand. distributor	2.091**	1.951**	1.909**	1.940**	1.866**	1.957**	1.961**
	(.8825)	(.8959)	(.9006)	(.8967)	(.9026)	(.8939)	(.9002)
Int. distributor	1.782*	1.590	1.563	1.582	1.563	1.595	1.604
	(1.033)	(1.003)	(.9949)	(1.003)	(.9926)	(1.002)	(1.001)
Ave. dom.rev.	-1.54e^{-06}	-1.61e^{-06}	1.59e^{-06}	-1.62e^{-06}	-1.45e^{-06}	-1.58e^{-06}	-1.54e^{-06}
	(2.02e^{-06})	(2.07e^{-06})	(2.11e^{-06})	(2.06e^{-06})	(2.06e^{-06})	(2.08e^{-06})	(2.10e^{-06})
Ave. for. rev	2.16e^{-06}**	1.98e^{-06}**	1.84e^{-06}**	1.97e^{-06}**	1.88e^{-06}**	1.98e^{-06}**	1.84e^{-06}**
	(8.49e^{-07})	(8.12e^{-07})	(7.72e^{-07})	(8.14e^{-07})	(7.73e^{-07})	(8.10e^{-07})	(8.04e^{-07})
Front role	.2500*	.2203*	.2014	.2157	.1896	.2308*	.2346*
	(.1351)	(.1330)	(.1310)	(.1336)	(.1365)	(.1366)	(.1340)
Periode 1	1.428	1.207	1.146	1.198	1.167	1.2105	1.209
	(1.064)	(.9638)	(.9257)	(.9636)	(.9245)	(.9627)	(.9421)
Periode 2	-.1505	-.3997	-.4493	-.4108	-.4907	-.4015	-.4058
	(1.059)	(1.137)	(1.126)	(1.135)	(1.132)	(1.139)	(1.137)
Year dummies	yes	yes	yes	yes	yes	yes	yes
Constant	-4.610***	-4.517***	-4.823***	-4.510***	-4.828***	-4.532***	-4.686***
	(1.288)	(1.317)	(1.319)	(1.321)	(1.325)	(1.304)	(1.302)
Wald chi2	33.59**	48.74***	95.95***	50.75***	113.65***	47.59***	69.58***
Pseudo R2	.2119	.2294	.2445	.2297	.2545	.2295	.2345

*indicates 0.1 significance level, **indicates 0.05 significance level, ***indicates 0.01 significance level

The interaction term between low level innovation projects and knowledge heterogeneity is introduced in model 3. The model tests hypothesis 2 stating that the relationship between foreign linkages and association with successful innovation project depends on the level of innovation. However, the model also re-tests the positive association proposed in hypothesis 1 by taking into account the interaction between innovation level and innovative performance. Model 3 indicate that knowledge heterogeneity increase the likelihood that an individual is associated with a successful innovation project. But the interaction effect of knowledge heterogeneity and low-level innovation projects aimed at variety is significantly negative. A Wald chi2 test confirms that the magnitude of the effects differs and shows a significantly negative net effect of knowledge heterogeneity for participation in projects aimed at variety.

Participation in productions subsidized through the consultancy scheme, and productions distributed by Scandinavian/North European distributors are positively associated with the probability of a nomination. One of the matching variables shows significant within group variation: the average performance on foreign markets is significantly positively associated with the probability of being nominated.

4.5. Robustness Checks

The results support the proposed hypotheses. However, we need to control for alternative explanations to ensure the robustness of the results and their interpretation.

The results could be caused by specific costs and benefits arising from connecting with a production in, for instance, Hollywood or London, and not by knowledge heterogeneity facilitated by participation in foreign projects in general. Therefore, foreign linkages to four distinct geographical locations were analyzed separately. I distinguish among five areas: Scandinavia (Norway,

Sweden, and Finland), Continental Europe (France and Germany), the US, Anglo-Saxon countries outside of the US (UK and New Zealand), and a residual category of other, less frequently occurring, countries. The results support the main results.

Furthermore, proximity and distance are not binary distinctions but rather a continuum. Some of the foreign contexts analyzed are more distant than others. The neighboring Scandinavian countries of Norway and Sweden, in particular, provide an accessible foreign context due to little geographical distance, low language barriers, and collaboration tradition. Geographical proximity increases the probability of tie formation (Sorenson and Stuart, 2008), and in our population a substantial part of the foreign linkages are with Norway and Sweden. 674 observations have foreign linkages with Norway or Sweden, while 382 have linkages with the US, 438 with other Anglo-Saxon countries (primarily the UK), and 555 have links with continental Europe. There is a clear bias in favor of Scandinavia. These differences in geographical and social proximity should lead to differences in degree of foreignness of perspectives acquired through collaboration in these foreign environments (Boschma, 2005; Hong and Page, 2001; Page, 2007). Consequently, knowledge heterogeneity acquired through linkages to Scandinavian countries should have a lower estimated effect on the probability for participation in a successful innovation project. Models 4 to 7 investigate and find support for this claim. The positive estimates on knowledge heterogeneity and association with a successful innovation project still holds. However, only in the case of non-Scandinavian foreign linkages do we find a significant effect.

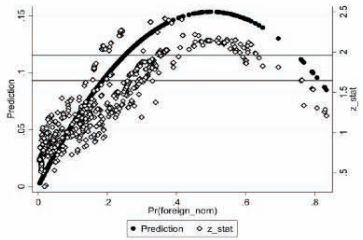
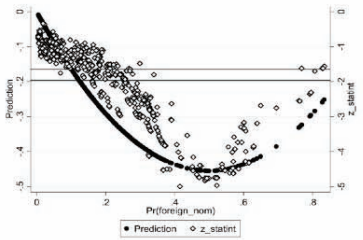
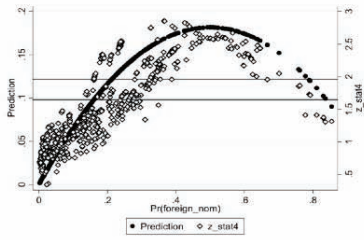
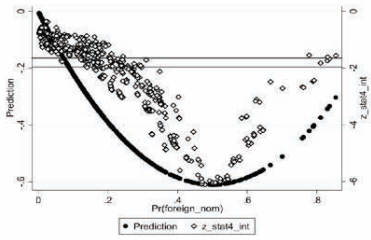
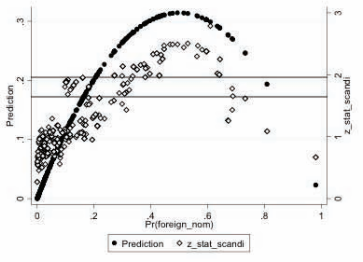
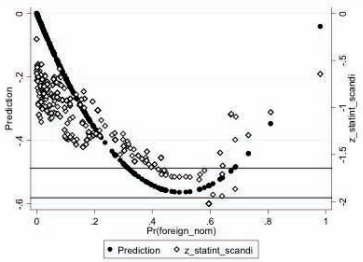
A final issue is related to the role of selection by other agents in the process of foreign linkage creation. To form foreign linkages and acquire heterogeneous knowledge, individuals need to be invited (and must accept the invitation) to join a foreign project. Within the European film industry, the idea and vision for a new film project are primarily formed by the director who develops them with the help of screenwriters and producers (Delmestri, 2005; Strandvad, 2008). Subsequently, the other potential participants in the production are

invited, and casting and selection take place. The findings might be the result of foreign agent selection bias in the casting and selection process. Therefore the role of other agent's selection is controlled for by estimating equivalent models for screenwriters and directors. The work of producers is context dependent because sets, non-creative collaboration partners, and local subsidy schemes comprise a substantial part of the context. Producers are therefore not included in this robustness check. Screenwriters and Directors enter the production process in the first phase and participate in defining the project. They subsequently select and invite the remaining cast and crew. Analyses of these 458 screenwriters and directors confirm the results, which means our findings are not caused by bias in the process of selecting talent.

The intuition from linear models cannot be applied to nonlinear models such as the logit model (Ai and Norton, 2003; Wiersema and Bowen, 2009). Therefore the analysis needs to extend the classic regression tables. Due to the logit function's structure, marginal effects vary with the probability distribution, and the optimal way to provide an overview of an estimated effect is thus a graphic representation. The main and moderating effects of models 3, 5, and 7 are displayed in table 4.3.

The main effect is positive for all observations in all three models. Though the association between knowledge heterogeneity and affiliation with a successful innovation projects is significantly positive in the estimated models, the effect is not significant for all the individual observations. The moderating effects are negative for all observations in all three models, but only significantly negative for the upper end of the probability distribution.

TABLE 4.3.
Graphical plots of main and moderating effect

	Main effect	Moderating effect
Model 3		
Model 5		
Model 7		

Marginal effects are calculated for meaningful values of all the variables based on the estimates in model 3. The most distinctive change in the marginal effect of knowledge heterogeneity is for differences in production budgets and previously generated revenue. The marginal effect of knowledge heterogeneity is a 27.6 percentage point increase in the probability of being associated with a successful innovation project for participants in a low budget film, and this decreases to a 24.4 percentage point increase for participants in a medium budget film, 16.4 percentage point increase for participants in a high budget film, and only a 7 percentage point increase in probability for participants in the few productions with extremely high budgets.

For participants in productions aimed at innovation through creation of variety rather than novelty, knowledge heterogeneity decreases the probability of association in a successful innovation by 78.2 percentage point for low budget productions, 78 percentage point for medium budget productions, 73.5 percentage point for high budget productions, and 54.6 percentage point for extremely high budget productions. Thus the magnitude of the marginal effects of the interaction term is affected less by budget size. The marginal effects in models 5 and 7 show similar trends. Marginal effects are larger for the early years of the analyzed period. The magnitude of the marginal effects decreases with increasing industry internationalization over time. The magnitude of the marginal effects also decreases when individual level average revenue (domestic and foreign) increases.

4.6. Discussion

The purpose of this study was to analyze the association between individual level knowledge heterogeneity achieved through foreign linkages and affiliation with successful innovation projects, and to examine whether the association was moderated by innovation level. Building on theories of innovation management, knowledge exchange, and the creative potential of knowledge heterogeneity I hypothesized that individual level knowledge heterogeneity

would be positively associated with participation in successful innovation projects, but that the relationship would be moderated by the innovative aim of the projects, so that participation in projects aimed at low levels of innovation would benefits less from knowledge heterogeneity.

Using a combination of social network methods and econometrics I tested and found support for the hypotheses. The results of this study show that individual level knowledge heterogeneity is positively associated with the individual's probability of being affiliated with successful innovation projects, and thus confirm and extend previous findings from project (Delmestri, 2005) and firm (Corredoira and Rosenkopf, 2010; Rosenkopf and Almeida, 2003; Rosenkopf and Nerkar, 2001) level studies. The paper provides further evidence of the value of knowledge heterogeneity. It contributes to previous literature by illustrating that benefits of knowledge heterogeneity in team production exist on the individual level. For the individual, the costs-benefits equilibrium of acquiring heterogeneous knowledge differs from what is found at the team and firm levels. The negative modifying effect of participation in a low innovation project indicates the importance of considering costs associated with individual level knowledge heterogeneity, which is often neglected in the literature. Knowledge heterogeneity increases coordination and communication costs (Bercovitz and Feldman, 2011; Delmestri, 2005). The added benefits of creative input from individuals with heterogeneous knowledge do not exceed these additional costs when the project aims at low levels of innovation. Specialization is preferable to knowledge heterogeneity when projects demand reproduction and variety rather than creativity and novelty.

Based on the graphic illustrations of the estimated effects, the conclusion is that knowledge heterogeneity is positively associated with participation in successful innovation projects, but that the relationship is only significant for the middle of the probability distribution. For some observations, no amount of resources will elevate their projects to the level necessary for international recognition. But for others, knowledge heterogeneity might provide exactly the foreign perspectives necessary to increase probability for success. The negative

moderating effect of innovation level shows a similar trend. Only the upper part of the probability distribution is significantly affected by knowledge heterogeneity.

The variations in marginal effects between project participants with different average project revenue, production budgets, and time of release indicate that the value of knowledge heterogeneity lies in the scarcity of perspective diversity. The magnitude of the marginal effects decreases when individual level average revenue (domestic and foreign) increases. The magnitude of marginal effects also decreases with increasing production budget size. Finally, marginal effects decrease during the analyzed period, as foreign perspectives becomes more generally available due to increased internationalization of the industry. Altogether, these results suggest that individual's heterogeneous knowledge generated through foreign linkages is one resource that could lead to association with successful innovation projects --- a large production budget or a good track record might provide similar competitive advantage. Also, the value of heterogeneous knowledge depends on its scarcity. With increasing internationalization of the industry, the benefit of foreign perspective for successful innovation decreases. Research on the U.S. biotech industry explains most of the network position-performance variation with variations in performance history (Lee, 2010). The findings of this paper do not contradict this, rather they suggest a more sophisticated approach to performance history, acknowledging that track records include more dimensions than merely economic performance, and that the acquisition of knowledge heterogeneity is one important dimension.

Individuals with foreign linkages thus act as oracles. They act as a source of wisdom in projects aimed at novelty creation. Their heterogeneous knowledge endows them with a higher probability of selection and contribute to successful innovation projects. However, for low-innovation projects aimed at innovation through creation of variety, the benefits of foreign perspectives do not outweigh the costs of routine disruptions, and the heterogeneous knowledge developed by project participants with foreign linkages is not called

upon. Under these circumstances, these participants become obstacles to smooth project management, which increase coordination and communication costs for the team.

The findings from this study can be generalized beyond the contexts of filmmaking and creative industries. As the importance of innovation increases, project organization and combining diverse perspectives becomes more essential. The key is to know how to organize for successful innovation. The insights provided by this study of a project-based industry are of general relevance for project organization of innovation. For organization scholars, the finding from this study on the value of knowledge heterogeneity at the individual level are similar to previous findings at project and firm level. But the findings also show that knowledge heterogeneity is positively associated with successful innovation rather than merely innovation. Finally, the modifying effects of innovation level on the probability of successful innovation show the contingent value of knowledge heterogeneity and raise the question whether this modifying effect exists only for participation in successful innovation.

One limitation of this study is the lack of information on the timing of the mobility event and the discrete nature of the variable measuring foreign linkages. In reality, the process of establishing foreign linkages must be expected to be a gradual development starting with establishment of weak social ties, which affect attention allocation (Corredoira and Rosenkopf, 2010), and assessment (Sorenson and Waguespack, 2006), and thus mobility opportunities (Granovetter, 1973). This gradual process of alignment for collaboration on foreign projects should be studied qualitatively. One approach could be a systematic analysis of the career paths of selected individuals who have successfully established foreign linkages. Such a study would rely on archival research and interviews and is beyond the scope of this paper.

Another limitation is the assumption of isolation of the feature film industry, which is in reality closely intertwined with the production of short films,

documentaries, commercials, live acting, music, and other creative industries. To quantify differences in an individual's engagement in the feature film industry compared to other creative industries is difficult. This study has tried to take these differences into account by including embeddedness in the feature film industry as one variable in the matching process. This addresses at least the issue of integration into the film industry and thereby removes selection bias based on project participants status in the industry.

The theories on which this study builds indicate a variety of mechanisms through which foreign linkages may be positively associated with participation in a successful innovation project. One avenue for future research would be to disentangle these mechanisms: to separately analyze the process of selection into projects and the contribution to these projects. However, this is beyond the scope of the present study and would require analysis of a different type of data with assessments of each project team member's contribution.

4.7. Conclusion

Based on analyses of a matched sample of project participants with and without heterogeneous knowledge developed through foreign linkages, I find that individuals endowed with heterogeneous knowledge are more likely to be associated with successful innovations. However, the positive association is moderated by innovation level. These findings suggest the innovation process benefits from heterogeneous knowledge, but that the cognitive costs of integrating foreign perspectives mitigates the value for individuals engaging in projects aimed at a lower level of innovation. These findings contribute to the discussion on knowledge exchange through labor mobility, by providing further insight on the moderating effect of innovation level on the association between individual's knowledge heterogeneity and association with successful innovation projects.

APPENDIX

Test of match on knowledge heterogeneity for 1860 observations, 930 with and 930 without knowledge heterogeneity

Matching variables	Dep. var.: knowledge heterogeneity
Local network position	-.0003
	(.0135)
Average domestic revenue	-1.09e-06
	(8.15e-07)
Average foreign revenue	2.70e-07
	(4.07e-07)
Front role type	-.0051
	(.1572)
Periode 1	-.0039
	(.2443)
Periode 2	.0052
	(.2126)
Constant	.1716
	(.2223)
Wald chi	2.06
Pseudo R2	.0028

Std. Err. In brackets

4.8. REFERENCES

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CHAPTER 5

CONCLUSION

This PhD thesis aimed to improve our understanding of why the benefits of co-location and embeddedness in collaboration networks are conditional. The main question of contingency was explored through a combination of perspectives from strategic management, economic sociology, and economic geography. The thesis departs from the notion that, co-location and collaboration networks become important, as ideas are often developed in project collaborations. Increasing interest in localization patterns of knowledge workers and the effect of knowledge workers location on prosperity emphasize the importance of understanding when and why co-location and different forms of collaboration increase performance. Knowledge of thresholds for co-location benefits will improve our understanding of the framework for embedded exchange. A further understanding of what is exchanged and the conditionality will increase our understanding of embedded exchange. This will enable understanding of which resources are exchanged in networks and at which points in the collaboration process exchange is improved or disadvantaged by embeddedness in collaboration networks.

In this dissertation, three modifying conditions were analyzed. The chapters addressed one sub-question each and were written as standalone papers each contributing to the overall question of contingencies for costs and benefits of co-location and collaboration. The main question of the contingent effects of embeddedness and co-location for performance was explored through the sub-questions:

1. *How and why does the attraction of co-location differ between groups of knowledge workers?*
2. *When does embeddedness in collaboration networks increase performance?*
3. *How does the value of individual level knowledge heterogeneity depend on the innovative aim of project collaborations?*

5.1. RESULTS

Chapter two addressed sub-question one through an analysis of the importance of co-location for different groups of knowledge workers. The chapter further aimed to explain why knowledge workers dependent on project organization have higher tendencies towards centralization. Using an original database, the distribution of the general population and two groups of knowledge workers were compared across 444 city regions in 8 European countries. Correlations of log rank – log size for each city region in the urban hierarchy were employed to study between group variations and deviations from the standard power law distribution. The results showed that both the population in general and the two groups of knowledge workers are distributed according to the typical rank-size rule of urban hierarchies, but that they exhibited different slopes and different distinct phases. The higher the demand for creativity, project organization, and use of freelancers a group of knowledge workers face, the steeper the slope of the distribution across city regions. These findings indicated that knowledge intensive groups have higher market thresholds due to specialization and need larger labor markets in central locations. Furthermore, the results imply that for groups engaged in project collaboration, embeddedness in localized collaboration networks is so essential, it affects location choices. The chapter concluded that centrality exerts a strong influence on urban hierarchies of creativity and that the study of creative urban city hierarchies yields new insights into the problem of centrality. Based on this study of dynamics at the aggregate level of regions, it seems that the most evident collaboration network effects should be found among knowledge workers engaged in project collaboration aiming for new product development.

The chapter contributed to the literature on urban hierarchies and literature on co-location of knowledge workers by demonstrating differences between groups with different preferences and types of labor. It showed how markets for potential collaboration partners in the form of specialized labor markets pull in highly creative knowledge labor.

Chapter three addressed sub-question two through an analysis costs and benefits of embeddedness in an industry network for performance in the domestic and foreign markets. The paper thus challenged the proposition of embeddedness as absolute and argued that the distinction between embeddedness and over-embeddedness depends on context. The analysis used data from the Danish films industry on all feature films produced between 1995 and 2005. Project participants' structural embeddedness in the industry network was quantified and included in econometric models predicting probability for economic performance in the domestic and foreign markets. The results showed that the association between embeddedness and performance vary with market type. The findings indicated that the costs and benefits of embeddedness depend on the level of uncertainty. With increasing levels of uncertainty, embeddedness mitigates performance. This divergence in performance is partly caused by accumulation of context specific knowledge through localized exchange, and partly by selection bias in access to foreign markets. Regardless of quality, projects by highly embedded individuals are more prone to gain access to foreign markets, due to selection bias among gatekeepers. Meanwhile, only the best projects by weakly embedded individuals are able to gain access to foreign markets. As embeddedness in the local collaboration network does not lead to abilities highly valued in foreign markets, selection based on embeddedness rather than merit leads to a negative association between embeddedness and economic performance in foreign markets.

Chapter four addressed sub-question three by analyzing the association between individual level knowledge heterogeneity and innovative performance. The chapter raised two questions related to knowledge heterogeneity and

innovation: First, whether individual level knowledge heterogeneity increases not only the potential for innovation but also the probability for successful innovation. Second, whether the association between knowledge heterogeneity and innovation depends on innovation level. Both questions were analyzed using data on all Danish feature films produced between 1995 and 2008. Econometric models including indicators on structural position in the industry network and acquisition of knowledge heterogeneity through foreign linkages were estimated. The results showed a positive association between knowledge heterogeneity and participation in successful innovation projects. However, this association was moderated by the innovative aim of the focal project. The probability for successful stylistic innovation increased with knowledge heterogeneity for individuals participating in projects aiming at the creation of novelty but actually decreased for individuals participating in projects aimed at product variety through incremental modifications to a predefined formula. The estimated models showed no significant effect of embeddedness in the collaboration network. The chapter contributed to the debates on redundant ties and access to foreign knowledge by addressing the association between heterogeneous knowledge acquired through foreign linkages and innovative performance for different levels of innovation. Furthermore, the paper explored the value of knowledge heterogeneity at the individual level which adds valuable insight to studies of firm and regional level knowledge heterogeneity.

5.2. Conclusion and Discussion

Based on the analyses presented in this thesis, I conclude that cost and benefits of co-location and embeddedness depend on the type of performance aimed for. Performance type influences both network structure and value of the exchanged resources. The presented findings show, that the choice of performance measure matters for the assessment of individual level costs and benefits of embeddedness. Chapter three clearly demonstrates variations in performance within different types of markets. And chapter three and four taken together shows that within the same network, structural positions vary in

effects on different types of performance. In chapter three, embeddedness affects economic performance positively in one market but negatively in the other. In chapter four, embeddedness in the local industry network has no significant effect on the probability for participation in successful innovation projects.

The findings of this dissertation illustrates, that even within the same industry context with common modes of production and collaboration, context greatly influence exchange of resources in collaboration networks. When aiming for innovation through novelty creation, foreign perspectives increase the potential for innovation. But when collaborations comply with predefined formulas, they mitigate performance. How resources are exchanged depends on the nature of that resource. Scarce resources such as opportunity allocation tend to follow strong embeddedness, while knowledge exchange and attention allocation follow weaker ties. Therefore, the cost-benefit tradeoff between tie development and maintenance depends on which resources are mostly needed for the purpose in question.

Previous literature showed how different types of ties increases innovative and routine performance respectively. The contribution of this thesis is a more differentiated analysis of knowledge workers and knowledge dependent performance. Performance for low level innovation projects suffers from the knowledge heterogeneity provided through foreign linkages, and benefits from embeddedness in local collaboration networks. More novelty creating types of innovation benefits the most from foreign perspectives, while reliance on predefined forms increases the benefits of localized knowledge accumulation. This points to difficulties of sustaining competitive advantage. Co-location increases other types of proximity, which at first facilitates collaboration but over time results in structural and cognitive inertia (Grabher, 1993). The findings in this thesis exemplifie two strategies for coping and transcending such inertia. Development of formulas either domestically or globally acknowledged as valuable outputs within their genre, or accessing foreign environments in order to acquire foreign perspectives.

Interestingly, the need to avoid inertia conflicts with the tendency for high co-location of creative knowledge workers. Creative industries are dependent on constant innovation (Caves, 2003; Delmestri, 2005; Lorenzen and Frederiksen, 2008) and demand uncertainty combined with short product life cycles leads to organization of the innovation process in collaboration projects and results in a tendency for high co-location. The tendency to co-locate is enforced through several social mechanisms (Sorenson and Stuart, 2001). So, individual knowledge workers face the problem, that co-location provides job-opportunities, access to resources, and knowledge exchange, but dulls the mind into a localized cognition which mitigates probability of reaching the path breaking creative results they aim for. Mobility is one potential strategy to keep the innovative edge. However, though labor mobility might benefit regions and firms (Agrawal et al., 2006; Corredoira and Rosenkopf, 2010; Rosenkopf and Almeida, 2003; Rosenkopf and Nerkar, 2001), the findings presented in chapter four indicate that for individuals, the value depends on participation in highly innovative projects.

The issue of co-location and propinquity runs through the thesis. In chapter two, the absence of information on actual collaboration patterns and co-employment leads to the implicit assumption, that co-location leads to other dimensions of propinquity. In general, existing literature argues for positively correlations between especially geographical, social and cognitive proximity (Boschma, 2005). However, the different operationalizations of proximity are clearly not substitutes. This potential bias is acceptable as the literature generally argues for strong correlations between different types of proximity and researchers point out when geographical proximity is challenged by other aspects of propinquity (Sorenson and Stuart, 2001).

In this dissertation, hypotheses were tested on data from creative industries and knowledge workers with creative occupations, however, the presented findings provide insight into general aspects of team production. As shown in chapter two, individuals holding creative occupations diverge more extremely

from the population in general than knowledge workers altogether. Yet, knowledge workers in general and individuals holding creative occupations display similar patterns of location. If we accept that these similarities in location patterns are caused by underlying similarity of preferences for amenities and labor markets, we must conclude, that knowledge workers within creative industries are not qualitatively different from knowledge workers altogether. They are rather more extreme representatives of a similar preference structure. The organization of collaboration projects among knowledge workers in general will resemble collaboration in creative industries and insights might be modified to suit both contexts. The reason for studying the chosen issues based on collaboration among knowledge workers in the film industry, is the freelance structure of organization which minimizes hierarchical effects on collaboration patterns (Grabher, 2002a, b; Lampel and Shamsie, 2003).

5.3. LIMITATIONS

All research has limitations, and this dissertation is no exception. To begin with, embeddedness in social structures and different types of ties all result in both costs and benefits. In this dissertation, I have primarily focused on benefits and on identifying optimal conditions for high performance. This practice is common in the literature. Coleman (1988) argues for the benefits of social closure in the creation of human capital, and thereby implicitly points to weaknesses of loosely integrated communities. When Granovetter (1973) emphasized the strength of weak ties, he concurrently claimed a weakness of strong ties. In Burt's (1992) analysis of the value of bridging structural holes in social structures, he simultaneously poses the argument, that strong ties have limitations. However, though not the primary focus, the costs of co-location and embeddedness is clearly present in each chapter. In chapter two, the reduced slope for the top ranking city regions are interpreted as congestion effects. In chapter three, the benefit of embeddedness is empirically shown to be limited to one of the two market types analyzed. And in chapter four,

foreign linkages clearly impose more costs than benefits for participation in low level innovation projects.

None of the chapters of this dissertation offers analyses directly linking individual embeddedness or foreign linkages to performance. The data structure does not offer possibilities for identifying individual contributions to collaboration projects. Though individuals receive recognition in reviews by critics and as awards and nominations, these cannot be exclusive assessments of that individual's ability to contribute to performance for two reasons. First, participation in projects resulting in recognition is a consequence of a three step process: opportunity recognition, selection to projects, and contribution to the selected projects. Furthermore, the complexity of film production leaves all individuals greatly depending on each other (Caves, 2003). Producers might ensure superb conditions but they are worth nil without a good script writer, directors cannot successfully direct untalented actors, and editors cannot excel if directors and actors do not deliver. This interdependence between roles further obstructs identification of individual contributions.

A final limitation of the analyses in chapter three to four is the reliance on registered patterns of collaboration. Collaboration networks can be compared to an x-ray of underlying social structures (Owen-Smith and Powell, 2004), but many weak ties are ignored in the analyses. The alternative was to base the study on interviews revealing cognitive social structures. Through interview with selected individuals, patterns of interaction among industry participants could have been identified. This approach would have provided greater insight into the nature and strength of interpersonal relations, but it would have biased the sample of individuals severely based on interview persons' acquaintance and perception of the social structure. It would thus have infused unacceptable bias into the econometric analyses of associations between embeddedness and performance.

5.4. Future Research

Further research is needed in order to indentify individual contributions to collaboration outcomes. To pursue this strategy, data including assessments of individual contributions to team production is needed. Preferably, all participants in the collaboration process should be expected to contribute equally and provide non-sequential inputs of the same nature – in other words, a setting of peers with little formal division of roles. Furthermore, all participants should be accountable for all parts of collaboration projects and held to the same standards of assessment.

Another interesting issue is how role in the collaboration process is associated with ego network structure and use. Future research should analyze the contingent value of embeddedness and co-location for individuals holding different roles in the process of novelty creation. In this dissertation a distinction was made between front role and all others in chapter three and four. Though I found no significant effects, this research strategy needs further development.

In this dissertation, the process of collaboration partner selection and collaboration outcomes for both team and individual has been left out due to lack of data. Tackling this issue will provide knowledge on the specific relational costs and benefits related to project selection and project participation respectively. Analyzing this issue requires data on multiple rounds of partner selection a population and data on potential partner attributes and contribution to project outcomes assessed for each individual.

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