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Knowledge Flows through Informal Contacts in Industrial Clusters: Myths or Realities?

by

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Abstract

The role of informal networks in the development of regional clusters has received a lot of attention in the literature recently. Informal contact between employees in different firms is argued to be one of the main carriers of knowledge between firms in a cluster. This paper empirically examines the role of informal contacts in a specific cluster. In a recent questionnaire, we ask a sample of engineers in a regional cluster of wireless communication firms in Northern Denmark, a series of questions on informal networks. We analyze whether the engineers actually acquire valuable knowledge through these networks. We find that the engineers do share even valuable knowledge with informal contacts. This shows that informal contacts are important channels of knowledge diffusion.

Key words: Informal contacts, regional clusters, communication technology

JEL Codes: L63, O15, D83

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1 Introduction

Many researchers have provided detailed studies of clusters with high performing innovative capabilities within the last ten years or so. Often clusters have been closely connected to leading edge universities in the business area of the cluster. Literature on Marshallian industrial districts (Brusco, 1990; Pyke et al., 1990; Russo, 1985) have argued that one of the explanations for the concentration of innovative activities has been that knowledge, developed in a cluster or industrial district, flows more easily within it, but slowly outside and across its borders. One of the proposed reasons is that informal networks of contacts emerge between individuals across firm boundaries acting as channels of knowledge flows. These channels of communication are argued to facilitate knowledge diffusion, giving firms located in clusters advantages regarding innovative performance. Numerous studies have highlighted the importance of these channels for the existence of clusters, with Saxenian (1994) as one of the most cited examples. Similarly, authors of econometric studies of the geography of innovation (many of which are reviewed by Feldman (1999)) have unanimously claimed that localized knowledge spillovers (LKS) of this kind are the main reason why innovative activity is geographically clustered.

Knowledge spillovers through informal contacts are just one of the externalities that are argued to be the main forces behind industrial clustering. From the classical work of Alfred Marshall (1890), Krugman (1991) derives three kinds of externalities that are important for clustering: (i) economies of specialization caused by a concentration of firms being able to attract and support specialized suppliers, (ii) economies of labor pooling, where the existence of a labor force with particular knowledge and skills attracts firms, which in turn attract and create more specialized labor, and (iii) technological externalities or knowledge spillovers (LKS), where knowledge and information flows more easily between actors located in a cluster than over long distance.

In his effort to integrate the geographical dimension into mainstream economic theory, Krugman (1991) dismissed the role of LKS by claiming that although they may exist in some high-tech industries, they are not an important force for agglomeration. Instead focus should be directed towards more measurable externalities such as economies of specialization and labor pooling. Krugman's claim has fueled an intense and sometimes hostile discussion with the community of economic and industrial geographers (see Martin and Sunley (1996) and Martin (1999) for examples of this debate) and other scholars as evidenced by the critical quotes in Jaffe et al. (1993) and Audretsch and Feldman (1996). In the quest to dismiss Krugman on this point, Martin (1999) claims that empirical studies of the geography of innovation provide clear evidence that LKS plays an important role in clustering of economic activity. However these studies have been criticized by Breschi and Lissoni (2001a), who argue that the concept of LKS is no more than a 'black-box' with ambiguous contents. In particular they argue that this literature neglects to distinguish between local knowledge flows that take the nature of public goods and those that do not. They suggest that studying in detail how

knowledge actually is transferred between individuals and firms located in the same geographical area is necessary to shed some light on this issue.

In the next section of the paper we present a review of the theoretical ideas that have been dominant in the debate on the role of informal knowledge exchange through personal contacts. Indeed we see informal knowledge exchange as an example of a channel of knowledge spillovers or Marshallian technological externalities. Consequently, we look only at the contributions that have looked at this as an isolated empirical and theoretical phenomenon. We argue that these theories possibly have contributed to the creation of the myth that clusters are driven by intense disclosure of detailed knowledge between firms. This myth has spread to the above mentioned literature on clusters and the geography of innovation. We confront the dominant theories with an alternative view, which has criticized the proposed role of informal contacts in clusters by arguing that they are used to disclose only very general information and ideas of minor importance, which is not an important explanation for clustering of economic and innovative activity.

To study the importance and extent of informal networks in clusters, we draw on a recent questionnaire study of the communications cluster in Northern Denmark (NorCOM). The discovery of NorCOM by Gelsing and Brændgaard (1988) relied on the same arguments for the existence of this cluster. They argued that informal personal networks are intensive between the employees, who carry knowledge through the cluster. Later, Dalum (1993) stated that the employees are highly related at the personal level and that there are many relations of a cooperative as well as a competitive nature. This helped the establishment of the dominant local view that the informal networks within the cluster were one of the main reasons for its fast growth in the 1990s.

This paper examines informal networks of contacts between employees in NorCOM and assesses whether these networks act as important channels of valuable and specific knowledge exchange between firms. Furthermore, we investigate the genesis of the informal contacts by studying relationships, experience and other factors influencing their extent. Unlike previous studies of NorCOM, this analysis is carried out at the level of the individual employee, in this case the engineer, in order to give a more complete picture of the informal network of contacts. Previous studies have been based on interviews with the managers of the firms, and we believe that such studies cannot completely reveal the extent and importance of networks.[1]

The remainder of the paper is structured as follows. The next section presents theories of the importance of knowledge diffusion through informal contacts in general and in clusters specifically. Section three builds testable propositions from the theoretical framework and describes the NorCOM Questionnaire Survey on which out analysis is based. The historical development and a review of the existing studies of our empirical case in terms of inter-firm relations are presented in section four. The results are presented in section five. Finally, the conclusions are presented in the last section.

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[1] Skarsø (1998) also uses the engineers as the unit of analysis, but does not deal with their relationship with engineers in other firms.

2 Knowledge Diffusion and Informal Contacts

The ideas of collective invention (Allen, 1983) are convenient for describing the dynamics of knowledge diffusion through networks and clusters. Collective invention is characterized by positive feedbacks of high invention rates and fast knowledge accumulation created by disclosure of information between competing agents. Collective invention is driven by exchange and circulation of knowledge and information within networks formed by groups of socially connected individuals.

Allen's ideas were based on case studies of the blast furnace industry in Cleveland (UK) in the middle of the 19th century, where producers shared knowledge about their furnaces, enabling them collectively to discover the positive relationship between productivity and the height of the furnace (Allen, 1983). Since then, other historical case studies have confirmed the ideas of Allen, for instance McGaw's (1987) study of the mechanization of paper manufacture in the Berkshire area (New England) from the beginning of the 19th century. Another example is Lamoreaux and Sokoloff's (2000) study of the American glass industry from the 1870-1925. These cases seem to be geographically bounded and thus relevant for general cluster theory. More recent developments of regional clusters, such as Silicon Valley, where rapid technological development is combined with a relatively open diffusion of knowledge (Saxenian, 1994), and the Italian industrial districts provide modern examples of collective invention (Russo, 1985).

Two particular aspects are worth noting about collective invention (Cowan and Jonard, 2000). First, participation in such communities requires a high level of technical knowledge and skill, which is needed to contribute to, and to take advantage of, developments within the communities. Second, reputation effects are very important, because the provision of information is motivated primarily by an expectation of reciprocity.

Although the idea of collective invention is appealing, it is primarily relevant to industries where firms do not spend substantial amounts on development of new knowledge. In these cases it is profitable to release technical information and knowledge, since it is expensive and nearly impossible to exclude others from the developments (Allen, 1983).

When similar firms are located in clusters (or industrial district-like environments), firms share a common set of values and knowledge so important that they form a cultural environment. In this environment, firms are linked together by specific informal relations in a complex mix of cooperation and competition (Brusco, 1990). In Saxenian's (1994) comparison of the regional agglomerations in Silicon Valley and Route 128, disparity emerges in the creation and character of networks. In Silicon Valley, informal contact between individuals is important, mutually beneficial, and widely observed. With a culture supporting informal relationships and a variety of regional institutions providing network services by arranging trade fairs, conferences, seminars, and social activities, the individuals (co-workers, competitors, former co-workers, suppliers, customers etc.) keep meeting each other, resulting in the formation of relationships and informal contacts. These are maintained and strengthened by ongoing activities. Technical and market information is exchanged, because the Silicon Valley culture lets them discuss details about their work. In the Route 128 case, informal contacts

were few and the culture discouraged networking, exchange of knowledge and problems. The extent of informal activity in Silicon Valley is perhaps unusual, but the level of interaction and information flow is important for the evolution of clusters in general. Enright (2001) uses the term *latent clusters* to describe clusters without a sufficient level of interaction and information flows.

The existing literature (e.g. Rogers, 1982; Von Hippel, 1987; Schrader, 1991) suggests that knowledge diffusion through informal channels happens as information trading. This type of informal exchange of knowledge between firms is a frequently observed phenomenon in product development, production and diffusion of technological innovations (see Martilla, 1971; Allen, 1984; Czepiel, 1974). Information trading refers to informal exchange of information between employees working for different and sometimes competing firms (Von Hippel, 1987). Colleagues in different firms provide each other with technical advice, expecting that their favors will be returned in the future. For instance, an employee in the production process might solve unforeseen technical problems by communicating with a colleague in a competing firm using the same production equipment. The colleague in the other firm has to decide whether to provide him with the information. If it creates disadvantages for his firm, he might want to keep it. Otherwise, he would disclose it with a future favor in mind (Schrader, 1991).

The transfer of knowledge represents a potential cost for the transferring firm. Competitive advantage decreases to an extent that depends on the value of the knowledge (Allen, 1984). In other words, the transfer of knowledge influences the firm's valuation of this particular piece of information. Schrader (1991) points to three factors influencing these expectations. First, the rents that the firm can expect to gain from a given piece of information are influenced by the degree of competition. If the firm transfers to a non-competing firm the change in rents are likely to be zero, unless the other firm transfers this information to another competing firm. Also, if the two firms have different competitive goals, the receiving firm might get the benefits without the transferring firm losing rents (see also Hamel et al., 1989). Second, the availability of alternative information sources has an effect on rent expectations, which depends on the time span for which the owner has an advantage relative to the inquirer of the information. Similar knowledge and information can often be acquired from other sources, e.g. suppliers or competitors. Consequently, the competitive advantage of a piece of information can be lost even if the transferring firm refuses to transfer to the receiver. Third, the rents are affected by whether the information relates to a domain in which the two firms compete. Firms are likely to compete along many dimensions, e.g. price, quality and consumer services. The decrease in rent expectations differ between these.

On the other hand, firms might also have rent benefits from transmitting information or knowledge. Studies by Von Hippel (1987) and Rogers (1982) show that the transfer of knowledge is part of a relationship based on mutual exchange. Schrader (1991) points to two different approaches. The first assumes that the partners are interested in continuing the relationship. A firm would weaken the relationship if it does not return the favor, which will keep it from gaining rents from knowledge received in the future. The other approach builds on the possible social aspects of exchange relationships. The lack of willingness to return a favor

induces guilt feelings and bad reputation. It is generally agreed that receiving a benefit will enhance the probability that the favor will be returned with a similar transmission of knowledge. This depends on the value of the knowledge or information. The higher the benefit, the larger the chance that it will be returned. Obviously, even if the receiver is eager to return the favor, the initial transmitting firm receives no gain from the relationship, if the receiver is unable to provide any beneficial knowledge. Therefore, Carter (1989) suggests that information trading firm tends to favor partners, that promise the most useful knowledge in return. Clearly, a firm is more interested in establishing relationships with another firm, which is at the forefront of technological development.

In Maskell et al. (1998) the creation of informal networks of contacts go through several phases, from relations between two individuals to entire networks. The transformation starts with transfer of knowledge between two individuals. Repeated interactions between the two lead to falling costs of future interactions by development of routines and conventions, which decrease costs. This makes the relationship stable. Both vertically and horizontally related firms may benefit from a climate of trust and mutual understanding. This will facilitate more informal contacts and interaction both at the level of the firm and the employee (Maskell, 2001). Maskell also stresses the importance of experimenting and testing different technological paths in clusters of horizontally related firms. They learn from the success and failure of others and are able to monitor, discuss, and compare other firms' solutions. Thereby, they participate in a continuous learning process by comparing different solutions, selecting, imitating and adding their own ideas.

Breschi and Lissoni (2001b) are critical of some of these ideas. Building on detailed studies, they make two main points (our emphasis). First, knowledge sharing through informal contacts is not likely to involve more than sharing of small ideas, which will not jeopardize the originators' rights to more strategic knowledge. Second, inter-personal communication is relatively more important for sharing knowledge with customers than with competitors (Lissoni, 2001). Moreover, Schrader (1991) finds

Even in epistemic communities containing members from competing networks, the engineers retain their loyalty towards the firm or the network they belong to. They exchange general rather than more specific knowledge. Although regional clusters are seen as homogeneous knowledge communities, the firms still tend to be specialized in narrow market niches with customized products. As a result, only a fraction of firm specific knowledge can possibly be diffused through informal contacts within a cluster (Lissoni 2001).

In summary, earlier theoretical contributions argue that knowledge is diffused through informal contacts. Across firms, colleagues provide each other with advice and solutions to problems. They disclose even firm-specific valuable knowledge with future favors in mind despite the fact that it could be a disadvantage to the firm. However, this has been criticized recently by other scholars arguing that agents will not disclose firm specific knowledge to external agents because of loyalty to the firm. They will only exchange more general knowledge of low value. Based on these conflicting we formulate two groups of propositions in the next section.

3 Building testable propositions

Based on the above two sections, propositions will be formulated below and tested in section five. They are divided into two groups according to the aims of the paper. The first deals with the type, extent and value of informal contacts, while the second focuses on their causes. We develop the following propositions on the basis of arguments from the advocates of the position that informal contacts between employees in different firms is an important source of knowledge for the firms, and that these networks will be an important agglomerative force.

3.1 Propositions group 1

When an engineer decides to share knowledge with an informal contact, he/she should ideally consider whether it is in the economic interest of the firm. However, he/she will look past that sometimes and disclose important pieces of knowledge even if it is a disadvantage for his/her firm. This type of transaction will take place because the engineers will expect to get valuable knowledge in return. The higher the benefits at the receiving end of the exchange, the larger the chance for reciprocation.

- **Hypothesis 1a: Firm-specific knowledge is exchanged.**
- **Hypothesis 1b: Knowledge acquired through informal contact is generally valuable to receiver.**

In the questionnaire we deal with this by asking the engineer whether he/she acquired knowledge through informal contacts that can be used in his/ her own work. Afterwards the engineer is asked to value that knowledge (high, medium or low) and to characterize it.

3.2 Propositions group 2

The contacts are informal exchange relationships. They are stable over time, since creation of informal contacts takes time to build up and involves trust and frequent interaction. Over time employees tend to keep in contact with former colleagues and classmates as they change job within a cluster. At first only low value knowledge is traded through a specific informal contact because of uncertainty about the relationship. But as the number of successful transactions and trust increases, it is possible that more valuable knowledge can be traded. Through a long working experience, an engineer gets in contact with more people and works in different project groups, firms etc. He builds up trust and reputation and therefore increases the number of contacts. Perhaps more importantly, he increases his *know-who* knowledge. This increases the extent of informal contacts and leads to the following hypotheses:

- **Hypothesis 2a: Relationships between engineers persist through time.**
- **Hypothesis 2b: More knowledge will be shared as the employees gain experiences, because of stronger relationships and increased trust.**

The employer has an incentive to prohibit diffusion of certain types of knowledge through informal contacts. In order to minimize the loss of competitive advantage from valuable knowledge, the firm wants to limit the possibility of employees disclosing information about their businesses. This leads to:

- **Hypothesis 2c: Firms want to reduce the extent of knowledge sharing with employees in other firms through informal channels to prevent competitors from getting valuable knowledge and secrets.**

These propositions are investigated in section five. We will now briefly introduce the questionnaire.

This paper draws on data from a recent questionnaire survey conducted by Michael S. Dahl, Bent Dalum, Christian Ø. R. Pedersen and Gert Villumsen (all from the IKE-Group, Department of Business Studies, Aalborg University) in November/December 2001. A questionnaire was sent to the engineers in the NorCOM firms. NorCOM is the name of a formal organization formed by some of the firms in the cluster. At present, there are 25 members of NorCOM out of the 35+ firms belonging to the cluster. The questionnaire was sent to the managers of the 25 NorCOM member firms. 19 of these managers agreed to recommend to their employees with engineering degrees (including computer scientists) to answer the questionnaire.

The engineers are the single most important resource for research and development in the cluster. In almost all of the firms they account for a high proportion of employment. After contacting the managers personally, we received information about the number of employees in this category. 791 questionnaires were sent to the 19 firms. 346 questionnaires were returned to us, which amounts to a 44 percent response rate.

After asking for some basic information and educational background, we asked about the following: (i) Working experience in communication technology and in different locations,

(ii) characteristics of their present job as well as important parameters in their job selection process, (iii) reasons for job changes, (iv) contact with other employees from other firms, (v) contact with departments and university staff, (vi) the need for, and use of, further educational opportunities, (vii) the importance of, and reason for, membership/non-membership of labor unions, and (viii) the entrepreneurial spirit and opportunities for the establishment of firms in the future.

In this paper and in the questionnaire, we define an informal contact as a person working in another firm (in the same cluster) with whom the engineer has a social relationship and who is not part of a formalized agreement between the two firms.

4 NorCOM – the wireless communications cluster in Northern Denmark

The ICT sector in Denmark employed approximately 109,000 persons in 1999, four percent of total national employment. The geographic structure of the Danish ICT sector measured by relative specialization indices shows a tendency to concentrate around the metropolitan areas and especially around two of the largest cities in Denmark, the Copenhagen region and Aarhus County. At the municipality level, the fourth largest Danish city Aalborg and surrounding municipalities, also show ICT specialization. Analysis of international specialization of ICT manufactured goods by the OECD trade statistics reveals that Denmark was specialized in the manufacture of mobile phones in the period 1990-1998. Denmark shares this specialization with Finland, Sweden, the United Kingdom and, in more recent years, France and Germany (Dalum et al., 2001). The Danish export specialization in manufacturing mobile phones is mainly concentrated in the Copenhagen region (with large subsidiaries of Nokia and Ericsson) and North Jutland (the region of Aalborg).

During the last two decades a cluster has emerged in North Jutland, which is focused on wireless communications equipment. The cluster is defined by a joint knowledge base, which includes electronic signals transmitted in the air by radio waves. It consists of approximately 35 firms with a total employment of 3,900. The total employment constitutes more than 40% of ICT employment in the region and approximately 1.6% of total employment.

4.1 The history

The history of the communications cluster can be traced back the foundation of SP Radio, a consumer electronics firm, in the late 1940s. The firm was founded in Aalborg in 1948 and the location factor was primarily personal preferences by the founder (Gelsing and Brændgaard, 1988; Dalum, 1995). In the mid-1960s the firm made a rather successful shift to production and development of professional maritime communications equipment. The region had a large fleet of fishing ships and other small vessels. In the following period SP Radio quickly became one of the market leaders in the segment for small and medium sized vessels. SP Radio remained an internationally well-known, technologically leading and competitive firm until the 1990s, when the firm went through a very turbulent period.

The next landmark in the emergence of the cluster was the foundation of Aalborg University (AAU) in 1974. Several "technical" knowledge institutions had been founded in North Jutland in the mid-1960s, but the university was a significant improvement and potentially a powerful education and research institution. In the following decades, AAU was one of two institutions in Denmark educating five year university candidates (M.Sc.'s) in engineering and became a very important factor in the cluster by creating a supply of specialized labor and basic research.

As in the history of other clusters, spinoffs were to play an important part in the emerging communications cluster. The first spinoffs came in the early 1970s, when engineers from SP Radio started the maritime communications firm, Dancom. In 1977 Simrad (also in maritime communication) and in 1980 Dancall (started in maritime communication, but switched early to mobile communications) spun off from Dancom. In 1985 Cetelco was formed as an affiliate of Simrad, containing its mobile communication activities. Dancall and Cetelco led the emerging cluster into a new technological area when they diversified into mobile communications from the very beginning of the boom of the Nordic Mobile Telephony network (NMT) in 1981. AAU played an important part in the diversification process and the subsequent strengthening of the mobile communications activities of the cluster by the strong research profile of its electronic engineering department.

In the late 1980s, a science park (NOVI) was founded in the region, located next to the university. The science park had a troubled start with few firms wanting to locate there. Nonetheless, for the emerging cluster the science park played an important role from the beginning, both as a knowledge institution and later on as a seed bed for new companies and a home for subsidiaries of foreign multinational companies. In 1988, Dancall and Cetelco established a pre-competitive joint venture company DC Development, located in NOVI. The aim of this joint venture was to develop a phone for the European mobile communications standard, Global System for Mobile Communication (GSM). When developed, the companies would add on their own features and compete.

The development of GSM as the second generation mobile phone caused significant changes in the communication industry in North Jutland. DC Development was a technological success. Dancall and Cetelco were in 1992 among the first handful of firms in the world to introduce a GSM mobile phone, but later they experienced financial problems and were acquired by foreign companies, and DC Development was closed down.

In the beginning of the 1990s, the cluster entered a new phase, with foreign capital and presence established by the acquisition of Dancall and Cetelco and the entrance of Maxon that acquired T-Com in 1991. The new Maxon affiliate became, like SP Radio and Dancall, an important element of the cluster's growth by generating spin-offs (RTX and Shima), mainly because of management disagreement with the parent companies. In 1991 the first private Danish phone company Sonofon was established in Aalborg and the cluster activities were complemented by a telecom service provider. Sonofon has approximately 950 employees in Aalborg and is the second largest provider in Denmark. Furthermore, foreign companies be-

gan locating in the cluster, several spin-offs emerged, and employment grew rapidly. There was a growing recognition of the communication cluster in this period (Dalum, 1993).

In the mid 1990s self-reinforcing effects resulted in a rapid increase in the local demand for engineers. The cluster grew from a total employment of a couple of hundred in the 1970s to 1,500 employees in 1995, reaching around 4,000 employees at the turn of the century. New spinoffs emerged and some of the most important multinational players in the communications industry established R&D activities in the region (Ericsson, Nokia, Motorola and Siemens). Foreign firms acquired many companies and several spinoffs were financed by foreign capital, supporting the rapid expansion of the cluster and strengthening its image as a development hub. But, as a negative effect of the foreign ownership, part of the decision-making power moved outside the region.

The recent turbulence in the ICT sector, not least in telecommunications, has affected the communications cluster, albeit to a fairly small extent. The trend towards physical separation of production and R&D and the lack of local manufacturing has consequently strengthened the profile of the cluster as a development hub.

4.2 Previous studies of informal contacts and other inter-firm relationships

A survey of links in the electronic industry in North Jutland in 1988 found only a few formal links, but interviews revealed the existence of many informal links (Gelsing and Brændgaard, 1988). This study, the first to map the relations between the firms by spinoffs, also found a high degree of mobility between the firms. Based on interviews, Gelsing and Brændgaard concluded that although the management disapproved of informal contacts and external knowledge diffusion, there were well developed informal contacts between technical personnel, who knew each other's job shifts and stayed in contact. Dalum (1993) confirms this through interviews at management level:

> *"… the informal personal networks (…) have been of significant importance. Below the level of top management there are intensive informal links between employees, even from firms who are competitors."(Dalum, 1993 p. 200)*

With no official cooperation between firms, technical personnel borrowed test equipment and spare parts from each other and small technical problems were solved by telephone calls to former colleagues or fellow students. The knowledge diffusion had the character of trade with expected reciprocity. Gelsing and Brændgaard (1988) claim that the informal contacts and subsequent knowledge diffusion was very important for the emergence of the cluster.

5 The Importance of Informal Contacts

The sample of engineers mainly consists of men (94%) with an average age of 33 years. Almost half of them are graduates from Aalborg University and their average work experience in the cluster is between four and five years, 62% have worked in the cluster four years or less. On average they have worked a little more than 2½ years in their current job and less than 25% have done so for more than three years. Their current function in the firms is described in figure 1. They are primarily engaged in research and development functions.

The important issue for this paper is whether the engineers are part of informal personal networks. The majority (76%) answer that they have at least one informal contact with employees in other firms in the cluster. Informal contacts are, as expected, a widespread phenomenon, which is shown in the top of table 1.

5.1 Value and specificity – Testing Propositions group 1

Do the engineers acquire any useful knowledge through informal contacts with persons in

Table 1: Engineers with at least one informal contact and their acquisition of knowledge.

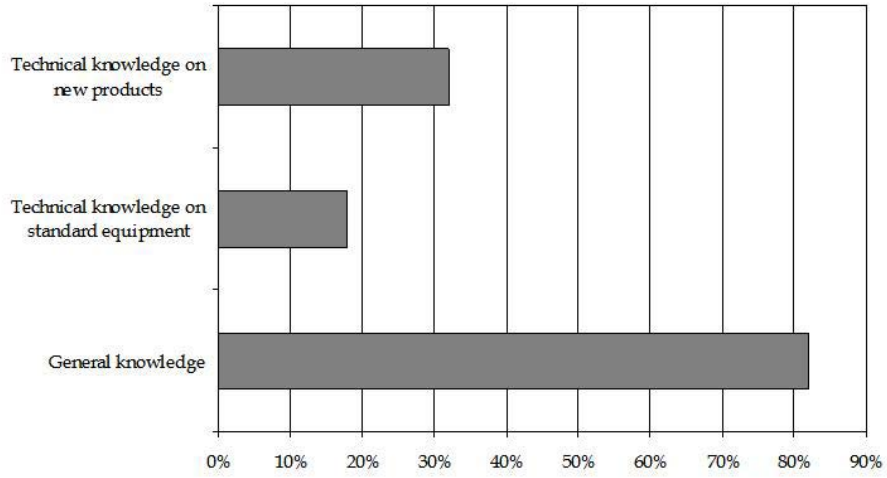
Question	N	Yes	No	Total
"Do you have informal contact with at least one employee in another firm in the cluster?"	342[1]	76%	24%	100%
"Do you acquire knowledge through your informal contact(s) that you take advantage of in your current job?"	258[2]	41%	59%	100%

1. This is equal to the total sample excluding four missing observations. Percentages are shares of this number.
2. This is the number of respondents with at least one informal contact.

Out of the engineers with informal contacts 41% gain knowledge from them. This means that the informal contacts do act as a channel of knowledge, since 30% of the total sample get knowledge from their contacts that they find to be useful in their own job. In comparison, Schrader (1991) surveys technical managers in the steel mill industry and finds that 83% of his sample had provided specific technical information to a colleague in another firm at least once during the last year. Schrader's study is however of the entire US steel mill industry, which is not geographically clustered, but his results suggest that these informal relationships across firms are important even across significant geographical distances. In a study of electronic and mechanical engineers working within four industries in the Brescia mechanical cluster, Lissoni (2001) finds that 30% of the engineers have a relationship of some kind with engineers in other firms. 60% of these relationships involve technical discussions, which is equivalent to 18% of the total sample. This is clearly conflicting with our results, but may be due to differences in the two samples. The present study is of a small cluster located in a small geographical area, the Aalborg region, with a fairly limited amount of firms with one common core technology, wireless communication. In contrast, Lissoni's study has a broader industrial specification and firms are located throughout larger geographical area. This could be the reason why we find higher shares of engineers with informal contacts and knowledge sharing.

However, we still know little about what kinds of knowledge are shared through these contacts. The critical literature claims that this knowledge will be general and not very specific. Indeed, Lissoni (2001) finds that 27% of the engineers' relationships involve only asking/giving generic suggestions and only 15% had discussion of current projects. His results show a lower level of information trading, from which he concludes that informal contacts do not go beyond the exchange of generic information. But, again, his study is broader as discussed above. Figure 2 shows how many engineers acquire different kinds of knowledge in our study.

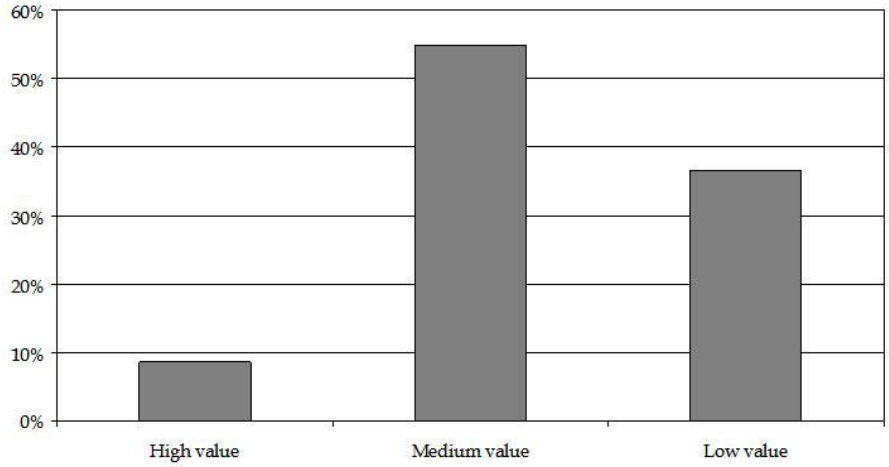
Figure 2: Type of knowledge acquired through informal contact



Note: The engineers were asked the following question: "Which type of knowledge do you acquire through your informal contact(s)?" and were given four options: general knowledge, technical knowledge on standard equipment, technical knowledge on new products, and other. The percentages reported are the total number of engineers, who acquire the particular type of knowledge, as a share of the total number of engineers who answered that he/she acquired knowledge from his/her contacts (104 respondents). The respondents can pick more than one type of knowledge in the questionnaire.

Engineers acquire all kinds of knowledge through their informal contacts. General knowledge is indeed diffused through this channel with more than 80% answering this. However, also more specific knowledge is diffused as more than 30% of engineers who acquire knowledge have gained access to technical knowledge on new products. In the bigger picture, this shows that 32% of the engineers with at least one informal contact get access to general knowledge from this contact. More interestingly 12% of these engineers also acquire more specific knowledge on new products. Clearly this means that informal contacts in other local firms cannot be neglected as being a channel of specific knowledge. This confirms hypothesis 1a. In this context it is interesting to see not only what type of knowledge is acquired, but also how this knowledge is of value to the receiving engineer.

Figure 3: Value of knowledge acquired through informal contact



Note: The engineers were asked the following question: "How do you rate the value of the knowledge that you receive from your informal contact?" and were given three options, high-, medium-, and low value.

Figure 3 shows the distribution of the value of knowledge across the three categories. More than 60% of the respondents that gain access to knowledge rate this to be of medium or high value to their own work. All in all these respondents are equal to almost 20% of the total sample. This gives a clear indication that the informal contacts are important sources of knowledge and that a significant share of engineers greatly benefits from these contacts in relation to his/her own work. This confirms hypothesis 1b. Similarly, 61% of Schrader's (1991) sample finds consider colleagues in other firms an important to very important information source and only colleagues in own firm was considered to be more important.

5.2 The genesis of informal contacts – Testing propositions group 2

Table 2 shows whom the engineers are in contact with. More than half of the engineers in the sample have informal contact with former colleagues in the cluster. This indicates that mobility is important for the extension of informal contact networks. The relationships created by engineers working together seem to last longer than for the time they are working together. The second largest category is former classmates. The results confirm hypothesis 2a, since the relationships created over time are persistent.

Table 2: Who are engineers in contact with?[1]

Category	Share of all engineers with at least one informal contact (N=259)	Share of entire sample (N=346)
Former colleagues	66%	49%
Classmates	50%	38%
Private friends	47%	36%
Others	8%	6%

1. The engineers were asked the following question: "Who are you in informal contact with?" They could pick more than one answer to this question.
Note: Chi-square test for share of engineers having contact with different categories reveals that the results are significant at a 1%-level.

To investigate further the role of mobility in the creation of informal contacts, we examine whether higher mobility will result in a higher probability of having at least one informal contact. There is no difference in the frequency of informal contact between the engineers with higher or lower than average mobility between firms. This is shown in table 3. The results are insignificant. Although the engineers keep in contact with former colleagues it is clear that above-average mobility does not increase the probability that they have at least one informal contact. Changing jobs does contribute with informal contacts to 66% of the engineers, but it does not increase the number of people with contacts. This indicates that a certain share of the respondents are not interested in or for other reasons reluctant to have informal relationships with people outside their own firm even though they worked with them in the past. Note, however that 16% of our sample have only recently entered the labor market (within the last two years) and are still working in their first job. They may be less likely to have developed informal contact with employees in other firms, as the probability of having at least one contact might increase with experience. This is investigated in table 4.

Table 3: Mobility and informal contact.

N=327	At least one informal contact	No informal contact	Total
Above average number of total job changes in career (high mobility)	78%	21%	100%
Below average number of total job changes in career (low mobility)	75%	25%	100%
Total	76%	24%	100%

Note: Chi-square test reveals that the table is not significant, i.e. there is no significant difference between high and low mobility.

The results for industry and cluster experience are very similar. Engineers with longer working experience are more likely to have at least one informal contact. This is not surprising, since the longer time they have worked in the cluster or in the industry the more conferences they have been at and the more different firms they have worked in. All of which increases their probability of having at least one contact. On the other hand, the engineers with low experience have worked in fewer firms and met less people, which give them a smaller probability. The share of more experienced engineers, who value the knowledge as high or average, is also larger than the less experienced. However, we cannot confirm that the engineers with more experience are more likely to acquire knowledge than less experienced, but

the knowledge they get certainly has a higher average value to them. This indicates that the greater experience the engineers have the better they are at acquiring useful knowledge from their contact. They know who they have to contact to get the knowledge or help to solve their problem. This enables us only partly to confirm hypothesis 2b.

Table 4: Experiences and acquisition of knowledge.

	At least one informal contact	No informal contact	Acquire knowledge	Does not acquire any knowledge	High or average value	Low Value
Cluster experience[1]						
2 years or less	68%	32%	37%	63%	50%	50%
3 years or more	82%	18%	43%	57%	71%	29%
Industry experience[2]						
3 years or less	69%	31%	38%	62%	52%	48%
4 years or more	82%	18%	43%	57%	72%	28%

1. Chi-square test reveals that the table is significant at a 1%-level (informal vs. no informal, N=342), is not significant (acquire vs. not acquire, N=258) and significant at a 5%-level (high vs. low, N=104).
2. Chi-square test reveals that the table is significant at a 1%-level (informal vs. no informal, N=342), is not significant (acquire vs. not acquire, N=258) and significant at a 5%-level (high vs. low, N=104).
Note: Generally, these chi-square test shows that there are significant differences between low and high experience for informal vs. no informal contacts and for high vs. low value, but the differences are insignificant for acquire vs. not acquire.

Having at least one informal contact could also depend on the function the engineers primarily hold in the firms. Table 5 shows the job functions of the sample. Engineers who primarily work with management issues are most likely to have at least one informal contact, although the share for the respondents working with R&D is not much lower. Production has a much lower share. More interestingly, the table also shows that management and production engineers have higher levels of knowledge acquisition compared with R&D engineers.

Table 5: Function in firm and informal contacts?

	At least one informal contact	No informal contact	Acquire knowledge	Do not acquire knowledge
Research and Development	76%	24%	36%	64%
Production	53%	47%	56%	44%
Management	81%	19%	55%	45%
Total	76%	24%	40%	60%

Note: Marketing engineers have been removed from this table due to too few observations. Chi-square tests reveal that the table is significant at a 6%-level for both informal vs. no informal (N=329) and acquire vs. not acquire (N=248). This shows that there are significant differences across job functions.

Not only do more managers have at least one informal contact, more of them also acquire knowledge from the contact(s) compared with R&D personnel. Managers are like to have worked their way up the occupational latter and perhaps started working as R&D engineers themselves in the beginning of their career. Consequently, they have more experience than the rest of the sample; they have met more people from other firms and know were to find the knowledge they need. Furthermore, their job as managers will perhaps also mean that they attend more conferences and other arrangements, where they might meet employees

from other firms. All this will increase their probabilities of having at least one contact and that they share knowledge. Schrader (1991) found percentages similar to these in his study, which only included technical managers.

Besides arising from mobility and other of the above factors, the initial contact between engineers from two firms could be created by a joint formalized project. If they work together on a limited joint project, there is a possibility that their relationships will last longer than the project itself. Engineers previously involved in formalized projects with employees from other firms in the cluster were also more likely to have informal contact than engineers not previously involved, as shown in table 6. It is plausible that some of the informal contacts arise directly from prior formalized projects. Working in a firm that previously has been in a formalized project with another local firm increases the probability that the employees have at least one informal contact outside his/her firm.

Table 6: Formal projects[1] in the past and informal contact.

N=342	At least one informal contact	No informal contact	Total
Formal projects	87%	13%	100%
No formal projects	73%	27%	100%
Total	76%	24%	100%

1. We define a formal project as a cooperative agreement between two or more firms.
Note: Chi-square test reveals that the table is significant at a 2%-level, which shows that formal projects are significantly different from no formal projects.

As proposed by Von Hippel (1987) and Schrader (1991), firms might discourage or even actively trying to prevent their knowledge from being shared with an outside party by their employees. Skarsø's (1998) interviews with managers indicated that this is the case in this particular cluster. The management culture in the firms might thus have influence on how and to which extent the employees share their knowledge with others. As mentioned earlier firms in this cluster became increasingly interesting objects of acquisition for multinational corporations (MNCs) throughout the 1990s. A interview-based study by Lorenzen and Mahnke (2002) reveals that the management culture of the MNCs have influenced the social networks of the acquired firms. After the acquisition, local networking is discouraged and networking within the organization of the MNC is encouraged. Clearly managerial regimes and culture can have an effect on the extent of informal relationships across the boundaries of firm and corporations.

It is publicly known that some of the engineers have competition clauses or non-compete covenants of various contents included in their employment contracts. These clauses can, for instance, limit the employee's possibilities to take a job in a competing firm or work with the same products immediately after breaking the contract. In our sample 16.2% of the engineers have a competition clause in their contract. We use these clauses as proxy for a firm's actions towards limiting the disclosure of knowledge to other firms through informal channels. We argue that firms, who include these clauses in the contracts of their employees, are also more likely to have policies preventing or discouraging their employees from sharing the firm's

knowledge with an informal contact. Table 7 shows the influence of competition clauses and the probability of having at least one informal contact.

Table 7: Competition clauses and informal contacts.

N=338	At least one informal contact	No informal contacts
Competition clause	63%	37%
No competition clause	79%	21%

Note: Chi-square test reveals that the table is significant at a 2%-level. Thus, there is significant differences between competition clause and no competition clause.

We find that the engineers, who have competition clauses in their contracts, are less likely to have at least one informal contact outside the firm. Only 63% of the respondents with a clause like this have one or more informal contacts. This shows that firms with restrictive managerial regimes, i.e. with competition clauses in the contracts, are successfully limiting informal networking between their employee and employees in other cluster firms. This supports hypothesis 2c, since firms are trying to limit the contact between their employees and other firms.

Previously in this chapter, we presented evidence that general knowledge is the type of knowledge, which is shared the most through the networks in this cluster. Notifications about new job openings etc. is frequently mention in the literature as a more general type of knowledge. Below we find some evidence for this point by looking at how the engineers primarily received information about their current job in relation to their participation in informal contact with engineers from other firms. The primary channels for information about current jobs were divided into network related factors, non-network related factors, as shown in table 8.

Table 8: Network and non-network primary channels for information about current job.

N=277	Informal contacts	No informal contacts
Non-network related factors[1]	69%	31%
Network related factors[2]	82%	18%

1. Non-network related factors: Internet job databases, job ads, the press, etc.
2. Network related factors: Former colleagues, classmates, employees in the new firm, etc.

Note: Chi-square test reveals that the table is significant at a 1%-level. Non-network and network related factors are significantly different.

Engineers with a least one informal contact made more use of network related factors as their primary channel for information when changing to their current job. This shows that the respondents with informal contact(s) to a larger extent use other channels to access knowledge about more general issues as e.g. new job openings. This is an example of the general knowledge, which flows through the informal networks of contacts between employees and between firms in the cluster.

6 Conclusion

This paper describes how the theoretical contributions arguing that knowledge is diffused through informal contacts have been criticized recently by scholars stating that agents will not disclose firm specific knowledge to external agents, because of loyalty to the firm. They argue that employees will only exchange more general knowledge of low value, which will not have disadvantages for their firms. However, we show in this paper that more specific knowledge is diffused. Even specific knowledge on new products, which is likely to be very firm specific and which the firms are likely to want to protect from competitors. A large share of the engineers questioned received knowledge from their informal contact, which they value to be of high/medium importance for their own work. This tells us that the informal contacts are an importance source of knowledge for the engineer in this cluster.

Besides exchanging knowledge about their products and technologies, the engineers might discuss more cluster-specific information and knowledge. Rumors about individuals or firms, future job openings and other information and knowledge like this are also likely to be part of the informal relationship. This channel is also likely to be used as a way to establish the reputation of the individual in the local environment. With a good reputation the engineer might be a valuable partner in future, more formal, co-operation between the firms, or as a future employee in the other firm.

Labor market policies can have vital influences on the extent of informal contacts and local communication between firms. As our results showed, competition clauses (or non-compete covenants) in the engineers' contracts limit external communication of the engineers. This can influence the development of a cluster and industry in general. Not only can these clauses affect informal networking, but restrictive legislation on what firms can demand in the clauses can have strong effects on the possibilities for an engineer to start a new firm. This can limit the evolution of clusters and hinder employment growth. This is shown by Stuart and Sorensen (2002) finding that the strength of enforceability in employees non-compete covenants strongly moderates the founding rates of new biotechnology firms in US states. Other studies (e.g. Silicon Valley (Brittain and Freeman, 1986) and the US automobile industry (Klepper, 2002)) have shown that clusters are often driven by spinoffs accounting for growth in employment and the number of firms. Restrictive policies towards the clauses could have positive effects on local and national economic development (cf. Klepper, 2001; Stuart and Sorenson, 2001; 2002).

Informal networks can play an important role for local development and the emergence of clusters. When an entrepreneur establishes his/her own firm, the location is very likely to be within a close distance to his/her previous employment. The entrepreneur keeps his local contacts, when the firm is established and he/she is already familiar with the local environment, which will improve the probability that the entrepreneur will succeed. This can be an important explanation for the emergence of the NorCOM cluster. An attractive labor market also is more likely to be the one of main factors behind the evolution of clusters in general and NorCOM in particular. Despite high demand and consequently a higher average wage for engineers in NorCOM, MNCs established a presence in the region in the 1990s to access

the local labor market. We believe that these two factors explain the emergence and evolution of clusters to a wide extent.

This paper gives insights on the existence and value of informal relationships to the individual employee. However, little is still known about the value to the firm and the effects of these relationships on firm performance. Future surveys linking the inter-firm informal contacts with firm performance will hold interesting evidence on how firms are influenced both positively and negatively by the exchange of their employees.

Furthermore, it would be fruitful to know more about how the individual are linked in networks of informal relationship across firms. Identifying how networks and epistemic communities exist in different sectors and regional levels could help measure how widely knowledge is exchanged through a network.

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The Research Programme

The DRUID-research programme is organised in 3 different research themes:

- The firm as a learning organisation
- Competence building and inter-firm dynamics
- The learning economy and the competitiveness of systems of innovation

In each of the three areas there is one strategic theoretical and one central empirical and policy oriented orientation.

Theme A: The firm as a learning organisation

The theoretical perspective confronts and combines the resource-based view (Penrose, 1959) with recent approaches where the focus is on learning and the dynamic capabilities of the firm (Dosi, Teece and Winter, 1992). The aim of this theoretical work is to develop an analytical understanding of the firm as a learning organisation.

The empirical and policy issues relate to the nexus technology, productivity, organisational change and human resources. More insight in the dynamic interplay between these factors at the level of the firm is crucial to understand international differences in performance at the macro level in terms of economic growth and employment.

Theme B: Competence building and inter-firm dynamics

The theoretical perspective relates to the dynamics of the inter-firm division of labour and the formation of network relationships between firms. An attempt will be made to develop evolutionary models with Schumpeterian innovations as the motor driving a Marshallian evolution of the division of labour.

The empirical and policy issues relate the formation of knowledge-intensive regional and sectoral networks of firms to competitiveness and structural change. Data on the structure of production will be combined with indicators of knowledge and learning. IO-matrixes which include flows of knowledge and new technologies will be developed and supplemented by data from case-studies and questionnaires.

Theme C: The learning economy and the competitiveness of systems of innovation.

The third theme aims at a stronger conceptual and theoretical base for new concepts such as 'systems of innovation' and 'the learning economy' and to link these concepts to the ecological dimension. The focus is on the interaction between institutional and technical change in a specified geographical space. An attempt will be made to synthesise theories of economic development emphasising the role of science based-sectors with those emphasising learning-by-producing and the growing knowledge-intensity of all economic activities.

The main empirical and policy issues are related to changes in the local dimensions of innovation and learning. What remains of the relative autonomy of national systems of innovation? Is there a tendency towards convergence or divergence in the specialisation in trade, production, innovation and in the knowledge base itself when we compare regions and nations?

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There are at present more than 10 Ph.D.-students working in close connection to the DRUID research programme. DRUID organises regularly specific Ph.D-activities such as workshops, seminars and courses, often in a co-operation with other Danish or international institutes. Also important is the role of DRUID as an environment which stimulates the Ph.D.-students to become creative and effective. This involves several elements:

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