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Knowledge flows through informal contacts in industrial clusters: myth or reality?☆

Michael S. Dahl*, Christian Ø.R. Pedersen

Danish Research Unit of Industrial Dynamics (DRUID), Department of Business Studies, Aalborg University, Fibigerstraede 4, DK-9220 Aalborg Oe, Denmark

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Abstract

The role of informal networks in the development of regional clusters has recently received a lot of attention in the literature. Informal contact between employees in different firms is claimed to be one of the main carriers of knowledge between firms in a cluster. This paper examines empirically the role of informal contacts in a specific cluster. In a questionnaire survey, we asked 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 quite valuable knowledge with informal contacts. This shows that informal contacts represent an important channel of knowledge diffusion.

Keywords: Informal contacts; Regional clusters; Communication technology

1. Introduction

Many researchers have provided detailed studies of clusters with high performing innovative capabilities over the last 10 years or so. Often, clusters have been closely connected to leading-edge universities in the business area of the cluster. Researchers who have studied Italian industrial districts (Russo, 1985; Brusco, 1990; Pyke et al., 1990) have argued that one of the explanations for the geographical concentration of innovative activities is that knowledge developed in a cluster or industrial district flows more easily within it, but more slowly outside and across its borders. One of the explanatory factors cited is that informal networks of contacts emerge between individuals across firm boundaries, and act as channels of knowledge flow. These channels of communication, it is argued, facilitate knowledge diffusion, giving firms located in

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* Corresponding author. Tel.: +45 96358268; fax: +45 98156013.
E-mail address: md@business.aau.dk (M.S. Dahl).

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clusters certain advantages regarding innovative performance. Numerous studies have highlighted the importance of these channels for the existence of clusters, with Saxenian (1994) being 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 frequently claimed that localized knowledge spillovers (LKS) of this kind are the main reason for the geographical concentration of innovative activity.

Knowledge spillover through informal contacts is just one of the externalities that are argued to be the main forces behind industrial clustering. From the classical work of Marshall (1990), Krugman (1991) derives three kinds of externality 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 labour pooling, where the existence of a labour force with particular knowledge and skills attracts firms, which in turn attract and create more specialized labour; and (iii) technological externalities or knowledge spillover (LKS), where knowledge and information flow more easily between actors located in a cluster than over long distances.

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, our focus should be directed towards more measurable externalities, such as economies of specialization and labour pooling. Krugman's claim has fuelled an intense, and sometimes heated, discussion within the community of economic and industrial geographers (see Martin and Sunley (1996) and Martin (1999) for examples of this debate) and among other scholars, as illustrated by the critical quotations in Jaffe et al. (1993) and Audretsch and Feldman (1996). In an effort 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 the 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 content. In particular, they argue that this literature fails to distinguish between local knowledge flows that take the form of public goods and those that do not. They suggest that in order to shed light on this issue, it is necessary to study in detail how knowledge is actually transferred between individuals and firms located in the same geographical area.

The next section of the paper presents, a review of the theoretical ideas that have been dominant in the debate about the role of informal knowledge exchange through personal contacts. Informal knowledge exchange is an example of a channel of knowledge spillover or Marshallian technological externalities. Consequently, we look only at those contributions that have considered this as an isolated empirical and theoretical phenomenon. These theories may 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. In this paper, the dominant theories are confronted 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. The role of the present paper is to confront these two views in an empirical investigation of the extent of informal networks and their role as channels of knowledge diffusion.

To study the importance and extent of informal networks in clusters, we use the results from a recent questionnaire study of the communications cluster in Northern Denmark (NorCOM). The discovery of NorCOM by Gelsing and Braendgaard (1988) relied on the same arguments for the existence of this cluster as are found in the dominant literature. They argued that informal personal networks are intensive between the employees, who carry knowledge through the cluster. Later, Dalum (1993) stated that the employees have strong personal relations and that there are many relations of a cooperative, as well as a competitive, nature. This helped to establish 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 channels of valuable and specific knowledge exchange between firms. Unlike previous studies (also of NorCOM), the present analysis is carried out at the micro level, in this case focusing on the engineer. Such a focus provides a better picture of the informal network of contacts, which constitutes

one advantage of the present paper. Previous studies have, for example, been based on interviews with the managers of the firms, and such studies cannot reveal completely the extent and importance of networks. The manager then becomes the only representative for matters inside the firm and in relation to the behaviour of the employees. The results are likely to be biased towards the manager's personal opinion and organizational policy.

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 3 builds testable propositions from the theoretical framework and describes the NorCOM Questionnaire Survey, on which our analysis is based. The results are presented in Section 4. Conclusions are presented in Section 5.

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 high invention rates and fast knowledge accumulation created by disclosure of information between competing agents. It 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 that enabled them to discover, collectively, the positive relationship between productivity and the height of the furnace (Allen, 1983). Since then, other historical case studies have confirmed Allen's ideas, for instance McGaw's (1987) study of the mechanization of chapter 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 1870 to 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 examples of industrial districts (Russo, 1985), provide modern examples of collective invention.

Two aspects of collective invention are worthy of particular note (Cowan and Jonard, 2000). First, participation in the type of community mentioned 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 is 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 the development of new knowledge. In these cases, it is profitable to release technical information and knowledge, since it is expensive and almost 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 by specific informal relations in a complex mix of cooperation and competition (Brusco, 1990). Saxenian (1994), when comparing the regional agglomerations in Silicon Valley and Route 128, points to certain disparities with regard to the creation and character of networks. In Silicon Valley, informal contact between individuals is important, mutually beneficial, and widely observed. With a culture that supports informal relationships and a variety of regional institutions that provide network services by arranging trade fairs, conferences, seminars, and social activities, the individuals (co-workers, competitors, former co-workers, suppliers, customers, etc.) meet each other often, which results 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 allows them to discuss details of their work. In the Route 128 case, informal contacts are few and the culture discourages networking, and the exchange of knowledge and problems. The extent of informal activity in Silicon Valley is perhaps unusual, but the level of interaction and information flow in combination with a rapid technological development is important for theories of clusters in general.

The existing literature (e.g. Rogers, 1982; Von Hippel, 1987; Schrader, 1991) suggests that knowledge

diffusion through informal channels occurs in the form of information trading. This type of informal exchange of knowledge between firms is a frequently observed phenomenon in product development, production, and the diffusion of technological innovations (see Martilla, 1971; Allen, 1984; Czepiel, 1974). Information trading refers to the 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 the provision of information will be reciprocated 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 that uses 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 reciprocity in mind (Schrader, 1991).

The transfer of knowledge represents a potential cost for the transferring firm. Competitive advantage decreases as the value of the knowledge transferred increases (Allen, 1984). In other words, the transfer of knowledge influences the firm's valuation of a 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 rent is likely to be zero, unless the other firm transfers this information to another competing firm. In addition, if the two firms have different competitive goals, the receiving firm might gain the benefit without the transferring firm losing rent (see also Hamel et al., 1989). Second, the availability of alternative sources of information has an effect on rent expectations, which depend on the time span for which the owner has an advantage relative to the acquirer of the information. Similar knowledge and information can often be acquired from other sources, such as suppliers or competitors. Consequently, the competitive advantage of a piece of information can be lost even if the transferring firm refuses to transfer it to the receiver. Third, 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, such as price, quality and consumer services. The decrease in rent expectations may differ between these.

On the other hand, firms might also receive 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. One approach assumes that the partners are interested in continuing the relationship. A firm would weaken the relationship if it did not return a favour, which would prevent 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 favour may induce feelings of guilt and a poor reputation. It is generally agreed that receiving a benefit will increase the chances of the favour being returned with a similar transmission of knowledge. This depends on the value of the knowledge or information. The higher the benefit, the greater is the chance that it will be returned. Obviously, even if the receiver is eager to return the favour, the initial transmitting firm gains nothing from the relationship if the receiver is unable to provide any beneficial knowledge. Therefore, Carter (1989) suggests that firms that trade information tend to favour partners that promise the most useful knowledge in return. Clearly, a firm is more interested in establishing relationships with another firm that is at the forefront of technological development.

According to Maskell et al. (1998), the creation of informal networks of contacts goes 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 through the 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, at the levels of both 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. In this way, 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 the ideas presented above. Building on detailed studies, they make two main points (our emphasis). First, knowledge sharing through informal contacts is not likely to involve more than the sharing of relatively small ideas, which will not jeopardize the originators' rights to more strategic knowledge. Second, interpersonal communication is relatively more important for sharing knowledge with customers than with competitors (Lissoni, 2001). Moreover, Schrader (1991) finds that friendships have no significant impact on the probability that information is traded. However, he also claims that friendship might define the extent of the network. Furthermore, physical proximity does not imply the existence of social proximity, since such epistemic communities (see Cowan et al. (2000) and Steinmueller (2000)) never include all members of the local community. Knowledge may be far from accessible to most of those located nearby (Breschi and Lissoni, 2001b). Knowledge circulates in small epistemic communities, which are centred around single firms, rather than flowing freely within clusters (Lissoni, 2001).

In analyzing the Brescia mechanical cluster, Lissoni (2001) finds that the communities consist of individual engineers linked by personal ties of trust and reputation. Although they arise from successful commercial partnerships and deals, the communities are not based on inter-firm arrangements, but respect the appropriation strategies of each firm. Accordingly, Breschi and Lissoni (2001b) argue that there might be several competing networks of firms in a regional cluster. The networks are built over time with the cooperation of partners, suppliers and customers. As a result of long lasting inter-firm cooperation, engineers have created their own 'codebook' and specific knowledge, which cannot easily be understood by competitors. Even in epistemic communities that contain members from competing networks, the engineers retain their loyalty to the firm or network to which they belong. They exchange general, rather than specific, knowledge. Although regional clusters are seen as homogeneous knowledge communities, the firms still tend to specialize 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 valuable firm-specific knowledge with future favours in mind, despite the fact that such disclosure could be a disadvantage to the firm. However, this view has been criticized recently by other scholars, who argue 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 views, two groups of propositions are developed in the next section.

3. Propositions and survey data

The propositions 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. The following propositions have as their basis the view that informal contacts between employees in different firms are an important source of knowledge for the firms.

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 to the disadvantage of his/her firm. This type of transaction will take place because the engineers will expect to gain valuable knowledge in return. The higher are the benefits at the receiving end of the exchange, the larger is the chance of reciprocation.

Hypothesis 1a. Firm-specific knowledge is exchanged through informal contacts.

Hypothesis 1b. Knowledge acquired through informal contacts is generally valuable to the receiver.

The questionnaire deals with this by asking the engineer whether he/she had ever acquired knowledge through informal contacts that could be used in his/her own work. Afterwards the engineer is asked to place a

value on that knowledge (high, medium or low) and to characterize it.

3.2. Propositions group 2

The contacts involve informal exchange relationships. They are stable over time, since the creation of informal contacts takes time and involves trust and frequent interaction. Over time, employees tend to keep in contact with former colleagues and classmates as they change jobs within a cluster. At first, only low-value knowledge is traded through a specific informal contact because of uncertainty about the relationship. However, as the number of successful transactions and the level of trust increase, it is possible that more valuable knowledge will be traded. Through long working experience, an engineer develops contacts with more people and works in different project groups and firms. He builds up trust and a reputation and therefore increases the number of his contacts. Perhaps more importantly, he increases his knowledge of who to approach for information. 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.

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 to informal contacts. 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 gaining valuable knowledge and secrets.

This paper draws on data from a questionnaire survey conducted in November/December 2001. A questionnaire was sent to engineers in the NorCOM firms. NorCOM is the name of a formal organization formed by some of the firms in the wireless communications cluster in North Denmark. During the last two decades this cluster has emerged in North Jutland focusing on wireless communications equipment. The cluster is defined by a joint knowledge base, which includes electronic signals transmitted by radio waves. At present, 25 out of the 35 firms in the cluster are members of NorCOM. The questionnaire was sent to the managers of the member firms. Nineteen of these managers agreed to recommend to those of their employees with engineering degrees (including computer scientists) that they 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. Seven hundred and ninety-one questionnaires were sent to the 19 firms. Three hundred and forty-six questionnaires were returned to us, which represents a 44% response rate.

After seeking 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 and important parameters in the process of selection for their present job; (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 labour 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 that is not part of a formalized agreement between the two firms.

A survey of links in the electronics industry in North Jutland in 1988 revealed only a few formal links, but interviews revealed the existence of many informal links (Gelsing and Braendgaard, 1988). This study, the first to map the relations between the firms, found a high degree of mobility of employees between the firms. Based on interviews, Gelsing and Braendgaard 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) confirmed 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 some expected reciprocity. Gelsing and Braendgaard (1988) claim that the informal contacts and subsequent knowledge diffusion were very important for the emergence of the cluster.

4. Importance of informal contacts

In the questionnaire survey, the sample of engineers consisted mainly of men (94%) with an average age of 33 years. Almost half of them were graduates from Aalborg University and their average work experience in the cluster was between 4 and 5 years; 62% had worked in the cluster for 4 years or less. On average, they had worked a little more than 2 and 1/2 years in their current job and less than 25% had done so for more than 3 years. Their function in the firms at the time of the survey is described in Fig. 1. They were engaged primarily in research and development.

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[a]	76	24	100
Do you acquire knowledge through your informal contact(s) that you take advantage of in your current job?	258[b]	41	59	100

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

The important issue for this paper is whether the engineers were members of informal personal networks. A majority (76%) answered that they had at least one informal contact with employees in other firms in the cluster. Informal contacts were, as expected, widespread, a phenomenon that is shown at the top of Table 1.

4.1. Value and specificity: testing propositions group 1

To investigate whether the engineers acquire any useful knowledge through informal contacts with employees in other firms, we look at the acquisition of

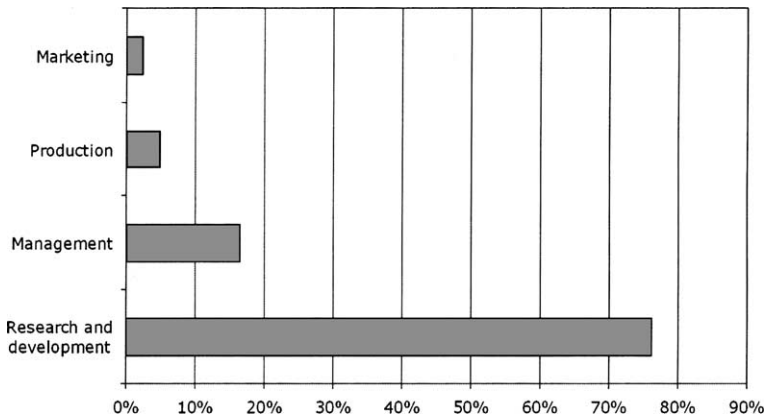

Fig. 1. Most important job function in the firm.

knowledge both in general and with respect to their specific job function. The engineers are divided into two groups: those who acquire, and those who do not acquire, knowledge through informal contacts that they can use in their current job. This is shown at the bottom of Table 1.

Of the engineers with informal contacts, 41% gained knowledge from them. This means that informal contacts do act as a channel of knowledge. Around 30% of the total sample acquired knowledge from their contacts that they found to be useful in their own job. In comparison, Schrader (1991) surveyed technical managers in the steel mill industry and found that 83% of his sample had provided specific technical information to a colleague in another firm at least once during the previous year. Schrader's study is of the entire US steel mill industry, which is not geographically clustered, but his results suggest that these informal relationships across firms are present even across significant geographical distances. Another noticeable difference between our study and Schrader's is that his questions are about whether the subjects of the study had provided information to a colleague in another firm, whereas we asked whether they had received information from contacts in other firms. This difference is potentially significant, especially when loyalty to one's firm is taken into account. It would be easier to state that one had received information, rather than state that one had provided a contact with information. This difference in the construction of the questionnaire should be borne in mind when comparing our and Schrader's studies.

In a study of electronic and mechanical engineers working within four industries in the Brescia mechanical cluster, Lissoni (2001) found that 30% of the engineers had a relationship of some kind with engineers in other firms. Sixty percent of these relationships involved technical discussions, which is equivalent to 18% of the total sample. This is clearly in conflict 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 number of firms with one common core technology, wireless communication. In contrast, Lissoni's study has a broader industrial specification and firms were located across a larger geographical area. This could be why there are higher shares of engineers with informal contacts and knowledge sharing in the NorCOM questionnaire. Another difference with similar implications concerns the characteristics of the two industries. There are rather large differences between the work practices and technological challenges in the more mature mechanical industry and the more unstable, but developing, wireless communication industry. The lower technological challenges could mean that engineers in the mechanical industry are less likely to seek information about future developments outside the firm. Consequently, this could also be a source of differences between the results.

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. Lissoni (2001) finds that 27% of the engineers' relationships involve only asking/giving suggestions of a general nature and only 15% discussed 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 general information. However, again, his study is broader, as discussed above.

Fig. 2 shows how many engineers acquired different kinds of knowledge in our study.

Engineers acquired all kinds of knowledge through their informal contacts. General knowledge was diffused through this channel, with more than 80% of respondents mentioning this. However, more specific knowledge was also diffused, shown by the fact that more than 30% of engineers who acquired knowledge gained access to technical information about new products. In the bigger picture, this shows that 32% of all the engineers with at least one informal contact gained access to general knowledge from that contact. More interestingly, 12% of those engineers also acquired more specific knowledge on new products. Clearly, this means that informal contacts in other local firms cannot be neglected as a source of specific knowledge. This confirms hypothesis Ia. 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.

Fig. 3 shows the distribution of the value of knowledge across the three categories. More than 60% of the respondents that gained access to knowledge rated the knowledge as being of medium or high value to their own work. All in all, these respondents constituted almost 20% of the total sample. This indicates

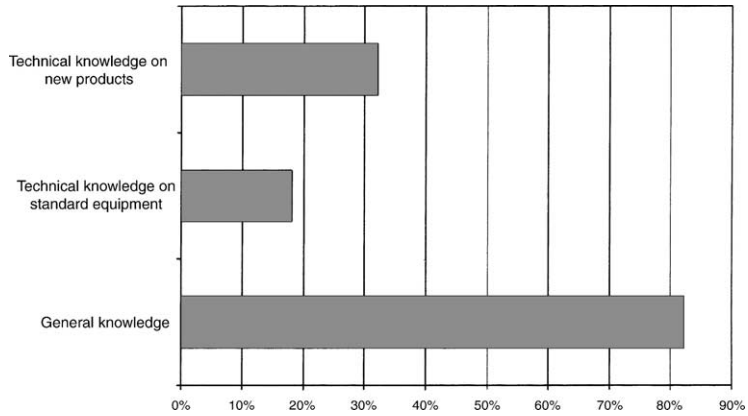

Fig. 2. Type of knowledge acquired through informal contact. *Note*: The engineers were asked the following question: "Which type of knowledge do you acquire through your informal contact(s)?" and were given four options: general knowledge, technical knowledge on standard equipment, technical knowledge on new products, and other. The percentages reported are the total number of engineers acquiring the particular type of knowledge as a proportion of the total number of engineers who answered that he/she acquired knowledge from his/her contacts (104 respondents). Respondents could pick more than one type of knowledge in the questionnaire.

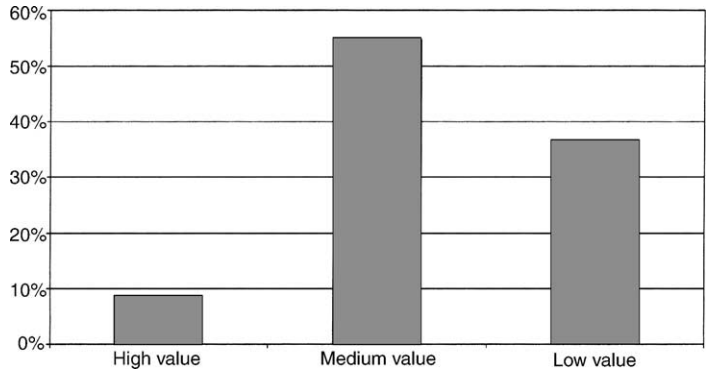

Fig. 3. Value of knowledge acquired through informal contact. *Note*: The engineers were asked the following question: "How do you rate the value of the knowledge that you receive from your informal contact?" and were given three options: high, medium, and low.

clearly that informal contacts are important sources of knowledge and that a significant proportion of engineers greatly benefited from those contacts in relation to their own work. This confirms hypothesis 1b. Similarly, 61% of Schrader's (1991) sample considered colleagues in other firms to be an important, or very important, information source and only colleagues in one's own firm were considered to be more important.

4.2. Genesis of informal contacts: testing propositions group 2

Table 2 shows with whom the engineers were in contact. More than half of the engineers in the sam-

Table 2
Who are engineers in contact with?

Category	Proportion of all engineers with at least one informal contact ($N = 259$, %)
Former colleagues	66
Classmates	50
Private friends	47
Others	8

Note: The engineers were asked the following question: "Who are you in informal contact with?" They could pick more than one answer to this question.

ple had 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 the actual time they work together. The second largest category is former classmates. The results confirm hypothesis 2a, since the relationships created over time are persistent.

To investigate further the role of mobility in the creation of informal contacts, we examined whether higher mobility results in there being a higher probability of having at least one informal contact. However, there was no difference in the frequency of informal contact between the engineers with higher or lower than average mobility between firms according to Table 3. The results are insignificant. Although the engineers stay in contact with former colleagues, it is clear that above-average mobility does not increase the probability that they will have at least one informal contact. Changing jobs does contribute in the form of informal contacts to 66% of the engineers, but it does not increase the number of people with contacts. This indicates that a certain proportion of the respondents are not interested in, or for other reasons are 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 had only recently entered the labour market (within the last 2 years) and were still working in their first job. They may be less likely to have developed informal contacts with employees in other firms, because the probability of having at least one contact may well 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 result 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 they have worked in the cluster or in the industry, the more conferences they will have attended and the more firms they will have worked in, each of which factors increases their probability of having at least one contact. By contrast, the engineers with little experience have worked in fewer firms and met fewer people, so there is a smaller probability that they will have an informal

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[a]						
2 years or less	68	32	37	63	50	50
3 years or more	82	18	43	57	71	29
Industry experience[b]						
3 years or less	69	31	38	62	52	48
4 years or more	82	18	43	57	72	28

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.

[a] Chi-square test reveals that the result 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, $N = 104$).

[b] Chi-square test reveals that the result 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, $N = 104$).

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 result 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.

contact. The proportion of more experienced engineers who place a high or average value on the knowledge is also larger than for the less experienced. While it cannot be confirmed that the engineers with more experience are more likely to acquire knowledge than those who are less experienced, the knowledge they acquire 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 contacts. They know whom they have to contact in order to acquire the knowledge or to help to solve their particular problem. This enables us to confirm hypothesis 2b only partly.

Having at least one informal contact could also depend on the function for which the engineers are primarily responsible in the firms. Table 5 shows the job functions of the sample. Engineers who work primarily with management issues are most likely to have at least one informal contact, although the proportion for the respondents working on R&D is not much lower. For those involved in production, the figure is much lower. More interestingly, the table also shows that management and production engineers tend to have higher levels of knowledge acquisition than R&D engineers.

Not only do more managers have at least one informal contact, but more of them also acquire knowledge from their contact(s) compared with R&D personnel. Managers are likely to have worked their way up the career ladder and perhaps started working as R&D engineers themselves at the beginning of their careers. Consequently, they have more experience than the rest of the sample; they have met more people from other firms and know where to obtain the knowledge they need. Furthermore, as managers, they might also attend more conferences and other events, where they may meet employees from other firms. All this will increase their chances of having at least one contact and of sharing knowledge. Schrader (1991) found percentages similar to these in his study, which included only technical managers.

Besides contacts arising from the above factors, the initial contact between engineers from two firms may be created by a formal joint project. If they work together on a specific joint project, there is a possibility that their relationship will last longer than the project itself. Engineers previously involved in formalized projects with employees from other firms in the cluster are also more likely to have informal contacts 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 has previously been engaged in a formalized project with another local firm increases the probability that the employees will have at least one informal contact outside his/her firm.

According to Von Hippel (1987) and Schrader (1991), firms might discourage their employees or even

Table 6
Formal projects[a] 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

Note: Chi-square test reveals that the result is significant at a 2% level, which shows that those who have engaged in formal projects are significantly different from those with no experience of formal projects.

[a] We define a formal project as a cooperative agreement between two or more firms.

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 result is significant at a 2% level. Thus, there are significant differences between employees with a competition clause and those with no competition clause.

actively try to prevent their knowledge from being shared with an outside party. The management culture in firms might thus have an influence on how, and to what extent, the employees share their knowledge with others. Firms in this cluster became increasingly interesting objects of acquisition for multinational corporations (MNCs) throughout the 1990s. An interview-based study by Lorenzen and Mahnke (2002) reveals that the management culture of the MNCs has influenced the social networks of the acquired firms. Following the acquisition of a firm by an MNC, local networking is often discouraged while networking within the MNC is encouraged. Clearly, managerial regimes and culture can have an effect on the extent of informal relationships across the boundaries of firms and corporations.

It is known publicly that some of the engineers have competition clauses of various forms included in their employment contracts. These clauses can, for instance, limit the employee's possibility of taking a job in a competing firm or working with the same products immediately after ending the contract. In our sample, 16.2% of the engineers have such a competition clause in their contract. These clauses are used as a proxy for a firm's actions towards limiting the disclosure of knowledge to other firms through informal channels. Firms that include these clauses in the contracts of their employees are also more likely to have policies that prevent or discourage their employees from sharing the firm's knowledge with an informal contact. Table 7 shows the relation between competition clauses and the probability of having at least one informal contact.

The engineers that 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 successful at limiting informal networking between their employees and those in other cluster firms. This supports hypothesis 2c, since some firms are trying to limit the contact between their employees and other firms.

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

$N = 277$	Informal contacts (%)	No informal contacts (%)	Total (%)
Non-network-related factors[a]	69	31	100
	43	61	47
Network-related factors[b]	82	18	100
	57	39	53
Total	76	24	–
	100	100	100

Note: Chi-square test reveals that both results are significant at a 1% level. Both informal and non-informal contacts, as well as non-network and network-related factors, are significantly different.

[a] Non-network-related factors: internet job databases, job ads, the press, etc.

[b] Network-related factors: former colleagues, classmates, employees in the new firm, etc.

Previously in this paper, we presented evidence that general knowledge is the type of knowledge that is shared the most through the networks in this cluster. Notifications about new job openings are frequently mentioned in the literature as an example of a more general type of knowledge. Below, we examine how the engineers primarily received information about their current job in relation to their participation in informal contacts with engineers from other firms. The primary channels for information about current jobs were divided into network-related factors, and non-network-related factors, as shown in Table 8.

Engineers with at 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 respondents with informal contact(s) use other channels to access knowledge about more general issues, such as new job openings, to a greater extent than those without such contacts. This is an example of the general knowledge or information that flows through the informal networks of contacts between employees and between firms in the cluster.

5. Conclusion

This paper describes how previous claims that knowledge is diffused through informal social networks have been criticized recently. Critics of these claims state that agents will not generally disclose firm-specific knowledge to external agents because of their loyalty to the firm. They argue that employees will only tend to exchange more general information of low value, which will not be so disadvantageous to their firms.

The present paper shows that knowledge flows through informal contacts do take place, using as a basis a survey of individual engineers in the NorCOM cluster. A large proportion of the responding engineers acquire knowledge from their social contacts, which they rate as being of high or medium importance for their own work. This tells us that informal contacts are potentially an important source of knowledge for the engineers in their daily working lives. Even specific knowledge about new products, which is likely to be very firm-specific and which the firms are likely to want to protect from competitors, is shared among these engineers.

Besides exchanging more specific knowledge about their products and technologies, the engineers also share more locality-specific information. It might be difficult to place a value on such information, but it could have an important function in updating and strengthening the network of informal contacts. This is potentially important for the dynamics of a local community, since a larger proportion of the engineers who reported that they have social contacts acquired their current job through a social network than those without such contacts.

Certain limitations of this study should be considered in future research. These are important relative to the broader questions raised in the literature and in this paper. This study shows that social networks and informal communication are diffusing knowledge between firms in a coherent group of firms located within in a rather small geographical area. Future research also needs to ask the individual in question to compare the value of knowledge thus acquired with other sources of information (e.g. colleagues in their workgroup, other colleagues in their firm, the internet, university-based research contacts, technical journals or similar sources). This would add to our knowledge of how more specific information and knowledge is actually exchanged, within and across organizational boundaries. The micro-level study of engineers should still be the unit of analysis, since the results may become more biased if the interviews and surveys are conducted at the level of the firm. It is impossible for managers to know the full extent, value and usefulness of each of their employee's informal social contacts.

This paper provides insights as to the existence and value of informal relationships to the individual employee. However, little is 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 investigations may provide interesting evidence of how firms are influenced, both positively and negatively, by the relations of their employees. The knowledge flowing through informal contacts is often considered in a positive light in the literature. The downside of information trading, for example the loss of information to competitors, which could potentially weaken a firm's performance, has to date, not received sufficient attention.

Furthermore, it would be constructive to learn more about how individuals are linked in networks of informal relationships across firms. Identifying how networks and epistemic communities operate in different sectors and regional levels could shed light on how widely knowledge is exchanged through a network. A limitation in the questionnaire used in this paper is the anonymity of the engineers. By asking engineers to name, say, their three most important informal social contacts in the cluster, it may be possible to map a web of informal contacts and to gain a more accurate picture of the extent of the social networks. This important issue is still to be addressed in the debate on the importance, characteristics and borders of these networks.

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