Brokerage in SME networks

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A B S T R A C T

This study focuses on SME networks of design and high-tech companies in Southeast Netherlands. By highlighting the personal networks of members across design and high-tech industries, the study attempts to identify the main brokers in this dynamic environment. In addition, we investigate whether specific characteristics are associated with these brokers. The main contribution of the paper lies in the fact that, in contrast to most other work, it is of a quantitative nature and focuses on brokers identified in an actual network. Studying the phenomenon of brokerage provides us with clear insights into the concept of brokerage regarding SME networks in different fields. In particular we highlight how third parties contribute to the transfer and development of knowledge. Empirical results show, among others, that the most influential brokers are found in the non-profit and science sector and have a long track record in their branch.

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1. Introduction

Firms are increasingly facing their own limitations in today's complex and demanding environment (Das and Teng, 2002; Duysters and de Man, 2003; Eisenhardt and Bird-Schoonhoven, 1996). The need for cooperation is evident in an environment characterized by uncertainty, complexity and rapid technological progress (Acs et al., 1996). Small and medium-sized enterprises in particular are faced by a dilemma. On the one hand, SMEs feel the urge to cooperate with others in order to acquire knowledge and other competencies; on the other hand they often face difficulties in finding partners and often they lack the knowledge base to be able to absorb the required knowledge. This dilemma clearly points to a need for intermediaries in order to deal effectively with the complex environment. Bridging organizations are needed to compensate for weaknesses in the local innovation system (Sapsed et al., 2007). Since intermediaries are becoming more and more important the need arises to provide SMEs with insight into what makes them so valuable. This information enables them to decide with what kind of intermediary they should cooperate.

Bridging organizations are gradually gaining attention in SME literature, but there is a clear lack of understanding regarding intermediaries operating within SME networking structures (Klerkx and Leeuwis, 2008). The subject of most network literature is related to the discussion on social capital versus structural holes. New in network literature is the idea of intermediaries whose commercial goal is to bring heterogeneous parties together and co-develop innovations, and not just exploit the knowledge (Obstfeld, 2005). The few existing studies in this area are based on research focusing on large enterprises (Hanna and Walsh, 2002; Pittaway et al., 2004; Shaw, 2005) or qualitative research in industrial districts (Kunmar et al., 1998; Morrison, 2008). Although SMEs are believed to provide vital energy and stimulate growth (Heilbroner, 1984; Schumpeter, 1934) and recently regained popularity as an important topic in the academic literature and policy-making programs (Audretsch and Thurik, 2001; Corbetta et al., 2004; OECD, 2000; Shane and Venkataraman, 2000), quantitative research on networks in entrepreneurship has been limited to the most rudimentary of network data, especially in the field of regional clustering (Burt, 2000; Ter Wal and Boschma, 2009). In addition the support instruments in programs unfortunately do not increase the interaction between SMEs and knowledge providers from outside the business sector (Kaufmann and Tödtling, 2002). It is still unclear how intermediaries can successfully bridge gaps or how specific characteristics influence the capacity of brokers.

The main focus of this study is on the SME network of design and high-tech companies in Southeast Netherlands. Although we consider SMEs, the far majority of firms in these industries are small firms. Design is seen as increasingly important in product development and there is an increase in efforts to establish co-operations between design and high-tech organizations. The design sector is a dynamic but highly fragmented industry. By highlighting the per-
sional networks of members across design and high-tech industries, the study attempts to identify the main brokers in this dynamic environment. In addition, we investigate whether specific characteristics are associated with these brokers. The main contribution of the paper lies in the fact that, in contrast to most other work, it is quantitative and that it focuses on brokers identified in an actual network (based on both suppliers and users of the knowledge infrastructure). Studying the phenomenon of brokerage will provide more insights into the concept of brokerage regarding SME networks in different fields. In particular it will highlight how third parties contribute to the transfer and development of knowledge.

The remainder of this paper is structured as follows. In the literature review section we provide a brief overview of the theory and the empirical field in which the research takes place. Then the methodology used to explore the SME network is described. We will end this paper with the main conclusions and a discussion of the findings.

2. Theoretical background

In a world of rapid economic and technological change, organizations increasingly interact with each other (Das and Teng, 2000; Eisenhardt and Bird-Schoonhoven, 1996; Hagedoorn, 2002). A complex environment especially affects small innovative firms because they tend to rely more heavily on technological developments outside the firm than large firms to obtain new knowledge (Hicks and Hodge, 2005; Porter, 2000). In their effort to survive and overcome resource scarcities SMEs are increasingly looking for competent partners that provide them with complementary assets and resources (Almeida and Kogut, 1997; Hite and Hesterly, 2001; McEvily and Zaheer, 1999; Narula, 2004). However, the complex environment and the limited resources and scanning abilities make it difficult for SMEs to find competent partners.

Another complication is the increasing drive towards specialization. Increased global competition leads to an increase in specialization; uncertainty and market fragmentation forces organizations, especially SMEs, to enhance flexibility and search for new ways to differentiate (Acs et al., 1996). Many organizations are forced to specialize in order to make sense of the overload of complex information nowadays. As a result, organizations increasingly have fewer knowledge bases in common and therefore lack a basis from which they can communicate with each other. Due to their differentiated technological know-how and large cognitive distance (Nooteboom et al., 2007) it becomes more difficult to communicate with companies outside their own industry (Nooteboom, 2000). Again SMEs are above all affected by this problem because they have less time and resources to spend on learning to acquire knowledge (Lavie and Rosenkopf, 2006; MacGregor, 2004; Narula, 2004; Powell et al., 1996; Syntens, 2000). As a reaction, intermediaries have emerged that assist entrepreneurs in coping with these challenges. However, the question remains: What makes a broker so valuable?

Finding a partner is often associated with uncertainty about both the skills of the potential partner and his reliability (Powell, 1990). Intermediaries claim to reduce this uncertainty by connecting heterogeneous partners in a prosperous way for all parties (Howells, 2006). In the Sectoral Systems of Innovation literature bridging organizations are regarded as organizations that compensate for weaknesses, such as the absence of domestic suppliers of key technologies, in the local innovation system (Sapsed et al., 2007). This literature points to the need for a better understanding of the structures and boundaries of the sector i.e. the agents and their interactions (Malerba, 2002). Related literature on regional clusters highlights the importance of leader firms in knowledge exchange among SMEs. Recent research has shown that knowledge does not circulate freely among local actors (Bianconi and Barabási, 2001; Verspagen and Werker, 2004). Firms with a strong knowledge base and firms which are at the core of knowledge networks are preferred partners. Close social, cultural, organizational or geographical proximity of firms’ matter less in knowledge exchange processes than assumed. Consequently the strategies and competences of leading firms in the SME network are important and are regarded as relevant for explaining local knowledge network dynamism and ultimately innovation activities (Giuliani, 2007; Morrison, 2008).

In network literature opinions regarding intermediaries stem from the concept of social capital which is seen as the value that arises from the way a person is connected to others. The concept includes two main arguments: closure (Coleman, 1988; Walker et al., 1997) and structural holes (Burt, 1992; Walker et al., 1997). Structural holes are gaps of value in the social structure between groups of people or organizations (Burt, 2005). Brokers span these holes and consequently are able to improve information flows between actors. Closure emphasizes in-depth exchange of information within a group of highly connected people. In the past the debate was about what form of social capital should be emphasized in network design. However research by Ahuja (2000) illustrates that actors’ strategic goals play an important factor in determining what type of social capital is most favorable. Related research suggests that both forms of social capital have to be present within networks, because firms want to efficiently absorb knowledge as well as create novelty (Gilsing et al., 2008; Hoang and Antoncic, 2003; March, 1991). Closure is needed in order to fully grasp the value created by brokering activities (Burt, 2005). The tertius iungens (those who unite) orientation described by Obstfeld (2005) is a network theory that is in line with the idea that bridging and bonding activities are intertwined. This approach discusses the role of companies that join alliances with the intention to co-develop expected network opportunities. They connect individuals in one’s social network by either introducing disconnected people or by facilitating new coordination between connected individuals. Those companies purposefully search for a role as integrator (Winch and Courtney, 2007). As discussed in the information system domain, the recognition of the existence of trust and cooperation in industrial districts helps to identify and create win-win strategies (Kunmar et al., 1998). The tertius iungens orientation emphasizes that being a broker is not about either spanning the structural holes or being highly connected, but about building bridges and being highly involved in the cooperation initiated.

The discussion regarding brokers has changed from whether or not brokerage is (more) valuable to how structural holes are being spanned. A quote from Hargadon and Sutton (1997: 745) describes clearly the contribution of such research to network theory:

“The network perspective treats network actors largely as conduits that pass along unchanged ideas and resources to others. Little attention is devoted to how or why those ideas and resources are transformed and combined into new solutions for other actors and subgroups.”

In the context of SMEs, the importance of third parties in building interfaces and developing knowledge is acknowledged in innovation and SME literature (Kaufmann and Todtling, 2002; Major and Cordey-Hayes, 2000; Sapsed et al., 2007). Very little network research however examines the role of third parties. According to Howells (2006) brokering is more than information gathering, exchange and linking functions. Intermediaries can provide a much wider, more varied and holistic role for their clients in the innovation process than has generally been acknowledged. The work of Snow et al. (1992) regarding the construction of business networks mention that managers operate as architects, lead operators and caretakers. Each role is critical to the success of a
(operational) network. The way brokerage activities are put into practice is likely to be dependent on what actors seek to enable (just as the form taken by social capital is dependent on what actors seek). The personal goals and interests of brokers influence brokerage behavior (Gould and Fernandez, 1989; Täube, 2004). These goals and interests seem in turn to be based on actors’ structural environment, kinds of relations, kind of information and personal characteristics (Brüderl et al., 1992; Burt, 2005; Kakati, 2003).

2.1. Concepts of brokers

A number of authors have described brokers or intermediaries (e.g. Burt, 1992; Gould and Fernandez, 1989; Klerkx and Leeuwis, 2008). In particular the concept of Gould and Fernandez (1989) generates more insight into brokerage behavior. Their concept of brokerage roles describes brokerage behavior as the facilitation of information flows whether or not a direct reward is involved. They argue that the various interests of actors will affect the way they seize the brokerage opportunities. Their theory recognizes five different types of brokers.

An individual \(j\) is said to broker between \(i\) and \(k\) (solid points in Fig. 1) if and only if \(i\) is tied directly to \(j\), \(j\) is tied directly to \(k\), and \(i\) is not tied directly to \(k\). Depending on different configurations of group membership among actors \(i\), \(j\) and \(k\), one of five types of brokerage relations may result. An actor in a network can fulfill several of these roles. On the one hand the actor can be a gatekeeper for the group he belongs to; on the other hand the actor can function as a liaison that passes along information to a cluster of people he does not belong to. This concept points to individual’s broker capacity in networks and also describes what types of brokers are present in a network. It provides information about the mixture of relations in a network. A lack of certain roles in a network tells us something about the flow and transformation of knowledge in the field.

2.2. Characteristics of brokers

Being a broker will not appeal to everyone. Whether or not people emerge as brokers seems to depend on the characteristics of people and the context in which they work. This paper focuses on affiliation, kinds of relations and kinds of information they receive (Brüderl et al., 1992; Gould and Fernandez, 1989; Ritter and Gemünden, 2003; Burt, 2005). We try to answer the question to what extent these characteristics relate to brokers’ capacity. The conceptual model (Fig. 2) specifies the relationship between these characteristics of people and brokerage capacity. The model will be highlighted below.

2.2.1. Affiliation

The affiliation of people can affect a person’s interests. Working in a profit, non-profit or science organization will influence behavior of people and consequently impacts on their personal network. Different kinds of people build different kinds of networks (Powell et al., 2005). The sector in which an actor is operating can influence the broker opportunity they face (Sapsed et al., 2007). It would be interesting to investigate whether individuals in the so called triple helix spheres (Etzkowitz and Leydesdorff, 2000) indeed face other broker opportunities, since the business community, knowledge institutions and government are a focal point of EU and national knowledge stimulation programs (EC, 2006).

Non-profit organizations provide collective support services to firms in the region. As intermediaries, regional (semi-) government agencies and non-profit discussion platforms facilitate the acquisition of competitive capabilities by compiling and disseminating knowledge and by reducing search costs (McEvily and Zaheer, 1999). Research by Van der Meulen and Rip (1998) shows that especially in the Netherlands there is a dense intermediary layer of network linkages between the institutions, committees, councils and programming bodies at the strategic research level which focuses on advising on science policy and also on the implementation of new initiatives in order to obtain ‘relevant science’. The government has moved to a role of enabling and stimulating contacts, instead of also carrying out scientific research.

Universities and research institutes are more focused on carrying out scientific research. However despite pressures put on them by other sectors to be relevant, they are still often guided by their own interests (Van der Meulen and Rip, 1998). They are important entities that can play a crucial role in innovation in increasingly knowledge-based societies (Etzkowitz and Leydesdorff, 2000). They indirectly transfer knowledge via the publication of research results, technology transfer or graduates offices, especially to SMEs in the high-tech sector (de Jong, 2006; Drejer and Holst Jørgensen, 2005; Hoppe and Ozdenoren, 2005). Furthermore they can function as a neutral and trustworthy partner to profit organizations (Boulding et al., 1997; Winch and Courtney, 2007).

The third grouping of the triple helix is the profit sector. SMEs are used to work with various partners. Maybe they work unconsciously as brokers? Research regarding public–private collaboration (de Jong, 2006; Drejer and Holst Jørgensen, 2005; Medda et al., 2006) shows that information from universities or govern-

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Fig. 1. Graphic presentation of the five types of brokerage. Open points represent the brokers. Ellipses correspond to subgroup boundaries (adapted from Gould and Fernandez, 1989).
ment laboratories is not seen to be decisive for the innovation process. On the contrary suppliers of materials and components are assessed to be at least moderately significant sources of information. Thus, although the non-profit organizations and universities research institutions do play a role in the knowledge development processes in innovative firms; this role is not as significant as those played by e.g. supplier firms, customers and even competitors. This is in line with the idea that exploiting inventions takes place in more closely related, homogenous groups (March, 1991).

2.2.2. Kind of partner

Not only do different kinds of people build different kind of networks, the kind of relations people have with others can also influence their network. A wide range of studies have highlighted potential contributions of partners to a company’s innovation efforts and the positive impact of technological interweaving on a firm’s innovation success (de Man and Duysters, 2005; Hagedoorn, 2002; Keizer et al., 2002; Powell et al., 1996). Customers, consultants, co-suppliers, administration, suppliers, researchers & trainers, competitors and distributors, all contribute in different ways to their partners (Gemünden et al., 1996). An organization can fulfill many of these partner roles; they can be a supplier to a company, but also a customer to another. Do brokers have specific preferences regarding partners? The partner’s role may affect the opportunities brokers face. The relations with researchers and administrators seem to be more enabling and supporting regarding innovation efforts (Grandinetti, 2003; Keizer et al., 2002). Customers (and co-suppliers) are seen as closely related partners with whom knowledge is mainly exploited. In addition to more formal business relations, people in organizations also have important informal, personal partners with whom they exchange work-related information. Personal relations in business are difficult to separate from formal relations. The two are clearly intertwined.

Again several kinds of relations can relate positively to broker opportunity depending on what is considered important by the respondent. This is in line with the opinion that brokers can full their brokerage role in many ways (Gould and Fernandez, 1989; Howells, 2006).

2.2.3. Kind of information

People who broker connections between others tend to posses certain kind of knowledge to fulfill this role successfully. What exactly is being brokered, the characteristic of the information itself can also be a factor of influence which distinguishes a broker from a non-broker. Even though a broker may be situated within a certain sector and interacts with certain partners, the kind of information they exchange with others may not always be the same. Do brokers merely focus on coordinating information, or is there room for exchange of in-depth knowledge? As described above, besides being coordinators of spanning activities, brokers can also be the producers of extra value (Howells, 2006; Obstfeld, 2005). Several studies have identified criteria that relate to entrepreneurship and successful business in a high-tech environment (de Jong, 2006; Chen et al., 1998; Kakati, 2003; Ritter and Gemünden, 2003; Sawers et al., 2008; Zahra et al., 2007). Marketing, innovation, management and finance are areas in which entrepreneurial persons need to have skills. Knowledge of these areas is a precondition to success in business. If any of these areas are not developed enough, the gap can be covered by a broker (Papagiannidis and Li, 2005). Besides the more resource-based information, entrepreneurial persons also need to manage network relationships. Initiation information, operational information, per-
sonal information and relationship-specific expertise are needed in order to manage a single relationship (Ritter and Gemünden, 2003). It is unclear what kind of knowledge is valued most in relations with brokers.

Empirical research will enhance our current knowledge about the existence and types of brokers present in various fields of industries. The investigation of brokers requires foremost insights into connectivity of an actual network. A construction of an actual network provides information about who has brokerage opportunities and thus who can be identified as the most successful broker. Detailed information about broker characteristics in relation to broker opportunities will provide insights into the involvement of brokers in building social capital in a network. Ambiguity about how brokerage activities are successfully put into practice can be diminished.

3. Research design

3.1. Research setting

This paper will study a network of SMEs in the design and high-tech industry. High-tech industries in the Southeast Netherlands are active in the fields of medical technology, high-tech systems, automotive, nano- & microsystems, ICT, the field of design & technology and new materials. The area is an important driver for the Dutch economy, contributing 15% of gross domestic product, 30% of industrial employment and almost 40% of the added value of total Dutch manufacturing industry (Sistermans et al., 2005).

The design and high-tech industries are particularly dynamic environments. These sectors are also becoming more and more important in modern economies (Jacobs, 2005). Recent government studies in the Netherlands and Great Britain emphasize the importance of the creative industry. It is a wide-ranging industry including arts & heritage, media and entertainment and creative business services of which the design sector is a part. Creative activities are defined as innovative activities that create value by adding a meaning, identity or experience to products or services (DCMS, 2001; Innovatieplatform, 2005). It is a sector which shows the necessity to cooperate in order to develop meaningful products. The creative industry is known for its short product cycles, high risk projects and rapid changes in production processes. Its social network is built on the principles of collaboration, participation, exploration and exploitation (Hartley, 2005). Actors are found to function as knowledge or technology brokers (Vanchan and MacPherson, 2008). Furthermore it is a sector which mainly consists of SMEs.

Over the past years design has become increasingly important to the manufacturers of high-tech products. The Southeast Netherlands is a top technology region in Europe which also shows a concentration of design firms. Design is increasingly seen as ‘business creator’; involved in developing and exploiting new ideas. Designers in this region are often asked to join firms at a very early stage of the innovation process (TNO, 2005). The region itself has a high concentration of elite knowledge and cooperation between wide varieties of organizations; SMEs, Educational institutions, University research institutes, large-scale industry and other knowledge institutions (Sistermans, 2005). The Southeast Netherlands will therefore be the starting point of our research.

3.2. Methodology

To get a closer insight into brokers and their characteristics an empirical study was conducted. A questionnaire was constructed to map the most important work relations between people who are active in the fields of design and/or technology. Respondents were asked to mention the names and organizations of at most ten of their Dutch business partners who had an important (qualitative) influence on their performance over the last five years. Partners who were most important to their work during the last five years were placed at the top of the ranking by the respondents. The limitation of five years was added to get insights in the present state of affairs since the industries are dynamic environments. Only Dutch partners are considered because the network would otherwise become too wide spread and fragmented.

The respondents had to specify the main role of the partner and the main kind of influence of the partner on their performance. The respondents were given examples of possible roles (customer, supplier, consultant, researcher, . . .) and the kind of influences (influence on innovation, marketing, organization, finance, . . .). In order to take into account the full richness of relationships in the network the respondent had to identify who was important to them in what way. Relationships within the actual network between actors i, j and k can be formal (business) as well as informal (personal) oriented; advice or trust related (Friedman and Podolny, 1992). It was not possible to identify upfront who is involved in what way in the network. Also by limiting respondents we may have excluded important relationships. Network analysts work around definitions by asking people to define their own relationships (Burt, 2005, p. 25). By taking this approach we pinpoint what the actors in the field consider important. The extra information about organization names and the content of relations enabled us to construct independent variables concerning broker characteristics. Table 1 lists and describes all variables. The independent variable sector was constructed by considering the organizations in which actors work. The answers of respondents regarding the role and influence of partners were divided into categories (Chen et al., 1998; Papagiannidis and Li, 2005; Ritter and Gemünden, 2003) as described in Table 1. The categorization was done by means of an expert panel. The expert panel consisted of 3 people who were senior non-profit consultants in the field of research and therefore acquainted with most of the mentioned people and their work. The expert panel was well informed on the various partner roles and kind of influences we instructed them to use. In cases where answers of respondents could not be assigned to a category directly, discussion regarding the work and relationships continued until unanimous agreement was reached. We extended the model of Gemünden et al. (1996) by making an additional category, that of informal discussion partner. By constructing the independent variable ‘informal’ we could investigate the influence of personal oriented network relations on brokerage capacity. Eventually we were able to sum per respondent the connection between the various kinds of partners and kinds of information. Control variables are gender, education level and working years in branch. Age was left out as a control variable because it showed a high correlation with the variable branch years. Gender may be of influence on brokerage capacity because women might be hindered in their access social capital. They are said to have less time to participate in business networks. Furthermore research indicates that women build closer relationships and share information, while men take on entrepreneurial roles and provide missing information and bridge organizational gaps (Timberlake, 2005). Also in order to seize opportunities, education and experience (human capital) seem to be a prerequisite, especially in knowledge-intensive industries. It enables actors to process complicated and diverse information more efficiently and consequently enables them to act faster (Madsen et al., 2008).

The survey was initially sent to a selected group of 33 people (2 female and 31 male) involved in design as well as in technology; sole traders as well as (managing) directors of Ltd companies. 3 organizations (of 33) were non-profit organizations. Firm sizes ranged from 1 to 37 fully employed persons. In the Netherlands 93%
of the firms in those industries have 1–10 employees (EIM, 2005). Therefore also 93% of the group out of which the 33 people are selected has 1–10 employees. 86% of our selected group has 1–10 employees. Although including rather small firms, the initial group is therefore representative for SMEs in the Netherlands. We decided to address the owners and directors since they are the driving force behind the social capital and innovative actions of these small firms. The respondents were asked to provide the names of work-related partners with whom they have the aforementioned relationship. Everybody who was listed in the response also received an invitation to fill in the survey. Data collection took place in several waves. This snowball technique is developed to identify hidden members and relation patterns (Hanneman and Riddle, 2005). This technique was a useful way to get a clearer picture of their network and relations.

We started distributing the questionnaire in January 2007. The results enabled us to construct the network between design and high-tech industries in July 29th 2007. At this point there were 468 names in the database. 405 persons received an invitation to participate. A social network was constructed based on the names and corresponding relations mentioned by these respondents. The results reported in this paper are based on the main component of the network which includes 440 names and 584 relations mentioned by 93 respondents. We focus on the group of 93 respondents. In this group the male respondents were slightly overrepresented (79/14), as were respondents from the non-profit sector (non-profit 31; science 12; profit 50). Respondents include SME entrepreneurs, but are mainly employees of SMEs. Results are based on individual dimensions of these people and thus represent individual brokerage characteristics. Although there are some SME entrepreneurs whose characteristics may represent their whole firm, most respondents’ brokerage characteristics only partially represent their firm. We choose to focus on the individual level because the academic literature suggests that knowledge should be viewed as a personal and specific asset (Morrison, 2008). Furthermore design and high-tech industries involve complex knowledge processes. Face-to-face intermediation of tacit knowledge and consequently close proximity is of importance when firms engage in complex business transactions with one another (Scott, 2006). Research by Zaheer et al. (1998) shows that although interorganizational trust must be present in exchange relations, increasing interpersonal trust clearly corresponds to lowering negotiation costs. From this perspective the individual level seems to be the most relevant level of analysis.

Social network analysis is used to draw the actual network and calculate the brokerage measures as proposed by Gould & Fernandez (1989) to detect brokers and brokerage roles. The network had to be divided into three groups; i.e. profit, non-profit and science. Depending on different configurations of group membership among actors in the field the five types of brokerage relations can result. Every actor can have several of these types of relations and thus fulfill several of these types. The individual raw brokerage scores show how many times a person fulfills specific roles in the network. The sum of all the individual raw scores, the overall raw brokerage level, indicates the individual’s total capacity for brokerage. Gould and Fernandez (1989; 98) describe that the overall raw brokerage level measures an aspect of an actor’s structural position, namely the extent to which the actor is capable of linking others in an indirect social relation, or equally importantly, of preventing such a link from being forged. It is a necessary, but not sufficient condition for actual brokerage behavior. The overall raw brokerage measure is used in our research to construct the dependent variable brokerage. There are other measures to detect brokers, but they focus on centrality positions and do not take into account differences in actors’ interests. The brokerage counts indicate which person has the most brokerage opportunities, and thus, in our research, who is the most important broker in the field. The sum of all the overall scores, the global raw brokerage level, provides information about brokerage in general in the network between high-tech and design industries.

### Table 1
Description of the variables.

<table>
<thead>
<tr>
<th>Type</th>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent (count variable)</td>
<td>Brokerage</td>
<td>Brokerage roles; Times a brokerage position is occupied</td>
</tr>
<tr>
<td>Control</td>
<td>Gender</td>
<td>Male or Female</td>
</tr>
<tr>
<td>Control</td>
<td>Education</td>
<td>Professional education (MBO, Applied Science University) or (Post-) University</td>
</tr>
<tr>
<td>Control (dummy variables)</td>
<td>Years branch 1</td>
<td>0–10 years</td>
</tr>
<tr>
<td>Control (dummy variables)</td>
<td>Years branch 2</td>
<td>10–20 years</td>
</tr>
<tr>
<td>Control (dummy variables)</td>
<td>Years branch 3</td>
<td>More than 20 years</td>
</tr>
<tr>
<td>Independent (dummy variables)</td>
<td>Non-profit</td>
<td>Public institutions, committees, councils and programming bodies</td>
</tr>
<tr>
<td>Independent (dummy variables)</td>
<td>Science</td>
<td>Universities, applied science universities, public research institutes</td>
</tr>
<tr>
<td>Independent (dummy variables)</td>
<td>Profit</td>
<td>Profit-oriented organizations</td>
</tr>
<tr>
<td>Independent (count variables)</td>
<td>Customer</td>
<td>Defining new requirement, solving problems of implementation and market acceptance, reference function</td>
</tr>
<tr>
<td>Independent (count variables)</td>
<td>Consultant</td>
<td>Advise regarding the product development process, innovative concepts</td>
</tr>
<tr>
<td>Independent (count variables)</td>
<td>Co-supplier</td>
<td>Co-producer at strategic or operational level. Supplier of complementary knowledge</td>
</tr>
<tr>
<td>Independent (count variables)</td>
<td>Non-profit consultant</td>
<td>Administration; advise regarding subsidies, regulations, political support</td>
</tr>
<tr>
<td>Independent (count variables)</td>
<td>Supplier</td>
<td>Producer of means of production</td>
</tr>
<tr>
<td>Independent (count variables)</td>
<td>Knowledge supplier</td>
<td>Research and training institutes</td>
</tr>
<tr>
<td>Independent (count variables)</td>
<td>Competitor</td>
<td>Joint basic research, establishing standards, getting subsidies</td>
</tr>
<tr>
<td>Independent (count variables)</td>
<td>Distributor</td>
<td>Dealers: Market and competitor information</td>
</tr>
<tr>
<td>Independent (count variables)</td>
<td>Informal</td>
<td>Informal discussion partner, informal contacts, producers of network information, reference function</td>
</tr>
<tr>
<td>Independent (count variables)</td>
<td>Innovation</td>
<td>In-depth product-related knowledge</td>
</tr>
<tr>
<td>Independent (count variables)</td>
<td>Finance</td>
<td>Information on finance-related issues</td>
</tr>
<tr>
<td>Independent (count variables)</td>
<td>Marketing</td>
<td>Information on market dynamics, customers and marketing</td>
</tr>
<tr>
<td>Independent (count variables)</td>
<td>Management</td>
<td>Information on strategy, structure and culture</td>
</tr>
<tr>
<td>Independent (count variables)</td>
<td>Network</td>
<td>Initiation information, network contact knowledge in order to be able to start relations</td>
</tr>
<tr>
<td>Independent (count variables)</td>
<td>Operation</td>
<td>Coordination information in order to tune with each other</td>
</tr>
<tr>
<td>Independent (count variables)</td>
<td>Person</td>
<td>Personal needs, requirements and preferences to establish social bonds</td>
</tr>
</tbody>
</table>

4 These percentages are in line with figures of the Dutch Chamber of Commerce.
4. Results

4.1. Brokerage in the network between design and high-tech industries

In SMEs the entrepreneur mostly fulfills the brokerage role. However, in larger organizations people with brokerage functions are much more difficult to identify. Furthermore in the design and high-tech industries, designers in particular are a rather hidden population. Some work in firms, some work as part-time freelancer, some have their own firms. By analyzing the network we get a clearer picture of brokers’ network and relations. Investigations of the degree to which actors actually are capable of mediating brokerage relations in the actual SME network do show powerful brokers. Almost every respondent has the capacity to broker. However the overall raw brokerage scores of respondents can be compared with random expected scores. It enables us to understand which brokers and types of brokerage roles are important. Despite the fact that the network does not have a high density and that there are many cases where the expected random number of relations is small, the identified brokers all differ greatly from what would be expected by chance. There is a large deviation between the expected values and the actual scores, indicating that our data is interesting.

To describe what kind of brokerage is important in the field the global raw brokerage scores are standardized. Table 2 shows the values. These standardized scores represent the total number of brokerage relations of each brokerage role actually present in the network. The significant values of gatekeepers and representatives suggest that actors in the system emphasize redundancy when searching for gatekeepers and representatives. In other words, organizations in the network tend to avoid depending on a few main brokers when they attempt to absorb knowledge from another group and when they use members of their group to communicate with other groups. The former is in line with the results of Cowan et al. (2007) who argue that a firm has a larger number of credible potential partners because it can gather reliable information about more firms. The significant value of liaisons suggests that there is close collaboration between the three groups. The significant positive value for the total raw global measure implies that actors in the system have sufficient capacity to broker relations.

A lack of roles in a network tells us something about the flow and transformation of knowledge in the field. Coordinator and cosmopolitan roles are trivial. Few individuals broker the information within a group. This may indicate that most actors organize their own network relations. Limited mediation of an outsider between members of the same group indicates that possible problems are dealt within the group. No outsiders are needed to exploit information.

This information provides insights about the mixture of relations in a SME network. It provides a relevant description of general broker characteristics in this field. The question remains if specific attributes are associated with the main brokers.

The facts that there are only the two brokerage concepts operationalized and that the concept of brokerage roles (Gould and Fernandez, 1989) is not put in practice substantially provides little basis for the generation of hypotheses. Therefore it is necessary to first take a look at empirical data. The actual network can provide insight into how actors grasp opportunities. One can argue that we take a grounded theory perspective by trying to show how people handle information problems. In our research it seems that there is no single way to handle information problems. Each person’s interest in each situation can be unique and therefore behavior can be different during each information exchange; individual characteristics per situation resemble an incident. By comparing these individual incidents we will investigate whether there are generic individual characteristics that can be related to general brokerage behavior.

4.2. Characteristics of brokerage

We tested for the relationships between the characteristics of people and brokerage capacity with controls for gender, education and years in branch as specified in Fig. 2 by means of negative binomial regression. All the variables in this research represent individual characteristics. Results are based on personal dimensions.

The dependent variable brokerage capacity (individual raw brokerage scores) takes on only whole number values. Researchers often use Poisson regression to analyze such count data. However our data shows overdispersion—the variance is greater than the mean. There is dependence between events (in this case total brokerages role counts) and the mean and variance of the observed distribution are thus not equal. Negative binomial regression explicitly accommodates this overdispersion. According to this method individuals have a constant, but unequal probability of experiencing an event; brokerage capacity (Cameron and Trivedi, 1986; Fleming, 2001). Instead of using the expected mean (λ), like poisson models, it replaces the mean with a random variable. This replacement allows the predicted mean to vary randomly according to a probability law; distribution of the error term. The probability of the observed count of a person becomes conditional on the error distribution (Fleming, 2001). In this way inter-person heterogeneity is allowed for.

Table 3 presents estimates for the negative binomial regression models of overall raw brokerage counts. Model 1 estimates a model of controls only, model 2 includes all variables and model 3 adds only substantive variable to the baseline model.

Checking for multicollinearity, the first step in analyzing data, indicated no extreme correlations between the independent variables except, as expected, between the profit and non-profit dummy variables. The non-profit and science dummy variable show the least correlation and are therefore included in the model. Furthermore relations with competitors and distributors were not mentioned by respondents as most important work relations. Therefore no variables could be constructed for these partner roles.

Model 1 is constructed to identify the influence of the control variables on the dependent variable. A log-likelihood ratio test shows that the control variables significantly improve the constant-only model. The test compares the fit of more complete and restricted models to determine whether the inclusion of variables of interest improves the prediction of the dependent variable. However the control variables do not improve the prediction of the dependent variable significantly. The calculation of the

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<td>Standardized global raw brokerage scores.</td>
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<td>Scores β</td>
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<td>3.593</td>
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*** p < 0.001.
...

- p < 0.01.
- p < 0.001.
adjusted pseudo $R^2$ (Hoetker, 2007) shows it is an improvement of just 1.7%.5

By taking model 1 as the baseline model in further calculations, log-likelihood ratio tests of the models 2 and 3 show that both significantly increase the explanatory power of model 1 at the $p$-value of 0.001. A comparison of the log-likelihood of model 2 and 3 also demonstrates that model 2 clearly contains variables of no influence. Besides we have to be cautious in putting too many variables in the model regarding the amount of observations. A model with substantive variables only improves, in this case, the prediction of the dependent variable the best. To construct model 3, log-likelihood ratio tests are performed each time a variable was included until none of the variables left improved the model significantly at the $p$-value of 0.05. The adjusted pseudo $R^2$ shows an improvement of model 3 by 16.58%.

Turning back to the results: Brokers seem to be present in the non-profit and science sector. Both sectors have a positive, but moderate significant coefficient estimate. (The opposite is true for the profit sector which is moderate significantly, negatively related to being a broker.) The work of Van der Meulen and Rip (1998) indicates that the main task of intermediaries in the Netherlands is to identify directions for programming ‘relevant research’ and thus linking basic science to socio-economic objectives. In other words, non-profit organizations are intermediaries between the science sector and profit sector. This observation is in line with our results. However individuals in the science sector also seem to have (moderate) brokerage capacity. Apparently those who are actually carrying out research are also at the crossroads of the network. It is important to be perceived as independent and objective in a broker-

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5 Calculations were made with STATA. The program calculates a McFadden’s pseudo-$R^2$; an equivalent goodness-of-fit measure to $R^2$ in OLS. Since it is a pseudo statistic it should be interpreted with caution. To avoid an overly optimistic sense of the models’ fit, the adjusted pseudo-$R^2$ was calculated alternatively.
The kinds of information variables show a different pattern. Innovation, network, operation, marketing and finance are significantly positively related with being a broker. Brokers have in-depth technical information and possess information on how to finance and market ideas. It seems that they are also operationally involved in brokerage activities. Furthermore they have valuable network information; they know people who might be of importance to others. The results are in line with Howells (2006) who argues that brokers fulfill many brokerage roles and thus also discuss a variety of information with relations. Totterman and Sten (2005) argue in particular that finance related initiatives are not the key aspect of support toward new companies. Focus should also be on the development of business networks. The results confirm that being positioned at the crossroads of a network has the advantage of enabling access to a wider diversity of information (Burt, 2005). Results regarding brokerage roles show that brokers perform as representatives, gatekeepers and liaisons. They provide information, filter information and inform various others more than they coordinate information among insiders. These results also indicate that brokers must have a more varied set of information available. The outcome regarding the kind of information shows that information on various topics is of equal importance to actors in the field and all is therefore discussed with intermediaries in order to reduce uncertainty.

In all the models experience in the branch is significantly important. Apparently it takes time to become a stakeholder in a sector (and branch) and gain relevant information on various topics. Although we asked respondents to mention who is an important business partner the last 5 years, the results indicate that those who have high brokerage capacity have been involved in the branch for more than 20 years. The main brokers must have been involved in various projects, as a direct or indirect business partner, in this field for at least a decade. The result shows that having experience and a broad knowledge base is valuable regarding brokerage. However, in small and large organizations, there is a tendency to focus on younger, less experienced people; people who are acquainted with the latest new knowledge, but who may not be well connected yet. Organizations must be careful in managing their knowledge base and social capital. A well balanced mix of personnel will influence the balance of bonding and bridging capital in organizations.

5. Conclusions

This paper investigated the existence of main brokers in the network across design and high-tech industries and modeled the relationship between a person's brokerage capacity and characteristics. Since the world surrounding organizations is becoming more and more complex, organizations will have to rely more on brokers to access external knowledge. Many companies find that they do not possess the necessary (scientific) resources to cope with additional burdens and seek external support to overcome their own cognitive and technical limitations. It is argued that the most successful brokers must have specific characteristics that enable them to transfer and develop knowledge optimally. The paper highlights individual's affiliation, kind of partner and kind of partner information as sources of brokerage capacity influence.

Empirical results show that there are actors with powerful brokerage capacity in the actual network. Instead of identifying brokers in the actual network, we could have started our research with a preselected group of brokers and constructed the network from there. However we would have missed information on less obvious brokers in the field. Furthermore we are not limited to a certain kind of broker or a certain sector. Our research enabled us to generate knowledge regarding brokerage in general. Consequently results can be relevant to other industries in dynamic environments in the Netherlands.

Empirical results also show that the most influential brokers are found in the non-profit and science sector and have a long track record in their branch. It seems that discussing finance is not sufficient. Actors in the field foremost like to discuss practical support in the form of valuable contacts and innovation-related information with intermediaries. However, finance, marketing and operational information is also discussed with them. The results show what specific characteristics influence the capacity of brokers. They also provide insight into how brokers bridge the cognitive and technical distance between parties. In other words, the research indicates how companies can reach a better balance between the two forms of social capital.

The research findings imply that SMEs should get involved in projects in the non-profit or science sector. Furthermore SMEs or even non-profit organizations whose brokerage capacity is not in line with their ambitions should invest in connections with branch experienced people with a broad knowledge base.

From a non-profit consultant point of view this research is also interesting. They often have difficulties in proving their successes. Sometimes merely mentioning contact information leads to a successful match. Sometimes brokerage takes much time and effort and still the involved parties are dissatisfied. Moreover the effectiveness of non-profit organizations is subject to discussion in the Netherlands. Branch associations for example are already dozens of years old. Their contribution to the individual company is difficult to perceive. This research shows that the intervention of their consultants (eventually) is of value to companies.

Still, in the high-tech and design sector new product-service combinations have been established which have not been created through traditional interventions. Traditional supply-side innovation policies seem to be insufficient to meet the challenges posed in promoting competitiveness. At the European Union level interest is focused on public procurement as a means to spur innovation (Edler and Georgiou, 2007). Regarding the effectiveness of government expenditures it is relevant to know how new networks come to exist and what roles intermediate organizations play. Measurement at individual level gives a profound picture of actual contributions. It is now possible to review policy from the bottom up.

Regarding the limitations of this study, we have little information on the representativeness of our sample for the total group of people involved in design and high-tech industries. A possible source of bias may be that the persons in the initial sample and first two waves have the advantage of being among the first mentioned. They have had more chance of being mentioned more often. Another possible source of bias is that the invitation to participate in the survey was signed by ourselves. Respondents might consider ourselves to be associated with a particular group, non-profit, and hence this may influence their willingness to participate in the survey. Furthermore we have asked respondents to mention important Dutch partners in Southeast Netherlands thereby excluding foreign subsidiaries in the network. The exclusion is a limitation of our study. Foreign subsidiaries are more innovative compared to domestic firms. Their innovativeness is heavily based on knowledge transfers from associated companies in addition to local knowledge. Therefore a foreign subsidiary can be regarded as an important partner. On the other hand they are inclined to cooperate less with domestic public knowledge institutions, especially when proprietary knowledge is concerned (Van Beers et al., 2008; Sadowski and Sadowski-Rasters, 2006). It seems that foreign individuals act as gatekeepers. Although some respondents have mentioned foreign partners who are working in the Netherlands our research did not take this perspective into account. However relations in the field are dynamic patterns of growth and
development and (brokerage) positions in a network partly reflect the past. The network represents a network across design and high-tech industries in the Southeast Netherlands, with all its specific structures. In other countries, other relationships are present. For example, in China the absence of institutional trust based on unpredictable government action and control, mistrust of strangers and shortage of reliable market information, leads to an absolute reliance on trust-based personal connections as a means for almost any transaction. The so-called Guanxi is the Chinese version of social networks (Zhou et al., 2007). The interaction between non-profit, science and profit sector are different in this country; therefore characteristics of brokers will be different. Related to this point, relations of people will vary per lifecycle stage of the industries. We noticed that collaborations between design and high-tech industries have only recently been stimulated. This particular network may be in an early life cycle stage.

We look at brokerage capacity from a network perspective. Network analysis is limited to tertius gaudens measurements. It is not yet possible to measure closed triple relations. Progress in those areas would be interesting. We do not measure the amount of brokerage an actor actually performs, although opportunity and actual behavior will probably correlate highly. What level of brokerage, what exactly is being brokered is also not measured (Burt, 2005).

Future, qualitative, research can complement this investigation by taking an in-depth look at what brokers actually do. In spite of the limitations, this paper represents one of the first empirical contributions discussing the issue of brokerage in SME networks.

A better understanding of brokers in SME networks can be a starting point for more work on the managerial and policy implications of brokerage.

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