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Innovation capabilities in very small firms – A study of 131 high-tech firms and their relation to performance

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Abstract:
Organizational capabilities have been widely discussed - most often at a conceptual level and from a large-firm perspective. This paper examines the operationalization and measurement of the capabilities for innovation in small (micro) firms and also how capabilities may be related to the firm's innovation performanc. Based on a quantitative analysis of 131 micro firms, this paper describes and analyses the dimensions critical for innovation with a special focus on very small high-tech firms. We propose a construct for investigation including five dimensions relating to small firm innovation capabilities and their relation to innovation performance. We found 20 relationships between the innovation capabilities dimensions and innovation performance, of which the dimension of Patent showed to be particularily correlated to capabilities. Our statistical analysis shows that two latent constructs have a positive effect on innovation performance Cooperation with universities and Business planning and advice. This paper contributes to the stream of literature on innovation capabilities. Firstly, we discuss the key notion of relating capabilities to innovation performance measures and presents a construct for that; second, in contrast to most existing studies, we address the notion of capabilities for small firms, and especially micro firms; research around organizational capabilities in various forms has hitherto mainly focused the large firm perspective. We highlight that both areas should be researched further.

Key words:, innovation capabilities, innovation performance, micro firms, new technology-based firms, incubators

1. Introduction

The capability literature is based on the Resource-Based View of the firm (Barney, 1991; Wernerfelt, 1984; Grant, 1996; Penrose, 1959; 1960). The literature on organizational capabilities describes how firms deploy their resources to develop competitive advantage (e.g. Prahalad and Hamel, 1990; Nonaka and Kenney, 1991) and how the resource base must be reconfigured and developed strategically to adapt to changes in the environment, according to the dynamic capabilities perspective (e.g. Teece et al., 1997; Eisenhart and Martin, 2000; Zollo and Winter, 1999, 2002; Helfat and Peteraf, 2003; Teece, 2007). Typically, the notion of capabilities is described in terms of firm building blocks (Christensen, 1999) or core capabilities (Leonard-Barton, 1992). Christensen categorizes an organization’s capabilities as consisting of: 1) resources; 2) processes; and 3) values, while Leonard-Barton describes the firm as the set of knowledge that provides competitive advantage. According to Leonard Barton, a firm’s capabilities have four dimensions: 1) employee knowledge and skills; 2) technical systems; 3) the managerial systems that guide the knowledge creation and control processes; and 4) the values and norms associated with these processes.

The capability to innovate (or innovation capabilities) and the associated organizational and strucural aspects were discussed by Assink, (2006) and Chiesa et al. (2001), but the research on this area is limited and largely conceptual. There is a need for more empirically based studies (Helfat et al., 2007; Zollo and Winter, 2003). Also the existing research and the knowledge and concepts developed are related mainly to large firms and the challenges they face to build and sustain capabilities. Very few studies focus on small firms. While a number of studies have looked at the impact of intellectual capital on small firm performance or the role of incubators, the other dimensions of capabilities and their relationship with firm performance for innovation have been overlooked.

New technology-based firms are new firms established with the purpose of exploiting an invention or technological innovation associated with a high technological risk (Little, 1979). These firms, therefore, are associated with high risk, but if they survive, can make a huge contribution to the region and industry in the long term (Lindström and Olofsson, 2001). In the present study, we study new technology-based firms or entrepreneurial firms. According to Borch et al. (1999), entrepreneurial firms exploit strategies related to innovation and growth characterized by risk taking. Van der

Auwera and Eysenbrandts (1989) propose a set of specific advantages related to small as opposed to medium/large new technology-based firms in Belgium. New technology-based firms enable greater job flexibility and are less hierarchical. The flow of information between management and production is faster, and they have a better overview of the innovation process. Small firms have direct relationships with suppliers and customers and can respond more rapidly to demand from abroad.

The small firms in our study are localized in incubators which aim to foster the development of new technology-based firms by mediating and facilitating the development of resources and capabilities. Many national and regional governments fund incubators to secure the survival and growth of new technology-based firms. In Sweden in 2010 there were more than 40 incubators, and around 900 at the European level (SiSP, 2007; CSES, 2002). This implies large sums of public money, which in turn implies the need for an evaluation of these incubators. According to Bergek and Norrman (2008) the concept of ”incubator” is often used as an overall denomination for organisations that are conducive to the ”hatching” and development of new firms (Chan and Lau, 2005). Aerts et al (2007) found that business incubators guide starting enterprises through their growth process and as such constitute a strong instrument to promote innovation and entrepreneurship.

We argue that there is a need to examine a broad set of capabilities and investigate the relationship to actual (innovation) performance for new technology-based firms, and especially very small high-tech firms (micro firms, 1-9 employees).

This paper discusses and analyses the dimensions critical to innovation performance. Our objective is to broaden the focus of both small firm capabilities for innovation and what these capabilities mean for firm innovation (innovation performance). The paper presents the findings from an exercise designed to measure the capabilities for innovation and innovation performance in 131 very small (micro) high-tech (and innovative) firms localized in 16 incubators in Sweden. In this study, we see capability as consisting of five dimensions (36 variables) and innovation performance as consisting of one dimension (5 variables). All the firms in the sample are research and knowledge-intensive and belong to sectors such as software/information technology, electronics/electrical, pharmacology and pharmaceutical preparations, mechanics, etc. The paper aims to contribute to the literature on innovation capabilities, and small firm performance in general.

This paper is structured as follows. In section 2, we present the key notions pertaining to innovation cababilities and innovation performance, and construct a research proposition in the study. Section 3 describes the methodology, the sample, means, frequencies and type of investigation. Section 4 presents the empirical findings and discusses the patterns of the linkages between innovation capabilities and firm innovation performance. Section 5 discusses the results and outlines directions for future research. Section 6 presents the main conclusions.

2. Framework and research proposition

2.1 Innovation capabilities and innovation performance

2.1.1 Innovation capabilities

Firm resources include all the assets, capabilities, organizational processes, information, knowledge, firm attributes, etc., controlled by the firm (Daft, 1983). These firm-specific heterogeneous resources fall into three general categories: (i) physical capital resources (plant and equipment); (ii) human capital resources (skills and know-how); and (iii) organizational capital resources (capabilities associated with formal and informal planning, controlling and coordinating) (Barney, 1991). Firm or capital resources are often referred to as capabilities and Tyler (2001) refers to physical, human or organizational assets that are superior to the assets of most competing firms. Technological capabilities refer to the firm's technical assets. According to Teece (1986, p. 288) 'an innovation consists of certain technical knowledge about how to do things better than the existing state of the art'. Teece (1989) notes that the complementary relationship between co-operative resources and technological innovation is also evident between firms. In general terms, organizational capabilities refer to what an organization is able to do. Organizational capabilities can be seen as the ability of the firm to deploy the available resources as its main assets (Prahalad and Hamel, 1990). They can also be defined (Helfat and Peteraf, 2003: 999) as 'the ability of an organization to perform a coordinated set of tasks, utilizing organizational resources for the purpose of achieving a particular end result'. Organizational research suggests that firms in dynamic environments with high levels of information processing, communication and knowledge transfer are more likely to develop competencies which will result in successful technology innovation, than firms in the same type of environments with lower levels of co-operative resources (Coff, 1997; Henderson and Cockburn, 1994).

More specifically, and relevant mostly to large firms, capabilities can be grouped (Christensen, 1997) into categories or building blocks: 1) the firm's resources, which includes the people, equipment, technology, product designs, brands, information, cash and relations with external partners; 2) processes, which are the methods/activities used for transforming inputs into higher value outputs and include the patterns of interaction, coordination, communication and decision making in an organization; and 3) values which are the criteria used for decision-making, or constitute the mindsets of the firm's decision makers. Teece (1989) describes that the complementary relationship between co-operative resources and technological innovation applies also to firms. Teece suggests that modern communications equipment serves to facilitate timely technology transfer necessary for parallel product development, and research and development (R&D) equipment as the physical capital resource which can be purchased by competitors. Thus, any competitive advantage will at best be temporary. In this view, capabilities are related to organization practice and organizational prerequisites.

Leonard-Barton (1992) adopts a similar perspective. She describes the firm's core capabilities as the set of knowledge that provides competitive advantage; according to her they include: 1) employee knowledge and skills; 2) technical systems; 3) the managerial systems that guide knowledge creation and control processes; and 4) the values and norms associated with these processes. Since 2000, the need to revise and develop organizational capabilities - the perspective of dynamic capabilities has been emphasized (Teece et al., 1997; Eisenhardt and Martin, 2000; Helfat and Peteraf, 2003; Zollo and Winter, 1999; Zollo and Winter 2002; Helfat et al., 2007; Colarelli O'Connor et al., 2008). Research shows that large, established firms face several different barriers to the development and commercialization of innovations (Colarelli O'Connor, 2008), and change is the main obstacle to developing capabilities for innovation in large firms.

In the case of small firms, research on 'capabilities' has been confined most to the role of incubators and commercialization and focuses much less on the notion of capabilities. Although the set of organizational capabilities critical for innovation differs between large and small firms, there are several individual elements that are common to both types of firms. Typically organizational capabilities in small or micro firms with one or only a few employees are oriented around the capabilities of one person and his or her ability to attract capital. Networks are especially important for small firms, and a can be seen as a resource that enables access to other resources and capabilities such as capital, innovation and advice (Zukin and DiMaggio, 1990; Uzzi, 1996, 1997). Entrepreneurial networks can be formal or informal (Birley, 1985). Informal networks include personal (friendship) relations, family contacts and business partners. Formal networks consists of suppliers of capital, such as venture capitalists and banks, creditors, and professionals such as accountants, lawyers and trade associations (Das and Teng, 1997). The use of external and internal networks reflects 'alliancing' capability (Eisenhart and Martin, 2000, p 1116).

Ackroyd (1995) identifies 11 distinguishing characteristics of small high technology firms, for example, lack of hierarchy and boundaries, high mobility, including growth and replication, and an impressive ability to respond quickly to technological and market developments. The findings from this study confirm that the external environment faced by micro firms has an impact on firm behaviour. The need for management and business planning increases when technology and environments change. A number of surveys of entrepreneurs has investigated the question of whether higher education level, a typical capability, is associated with smaller firms that show better performance than compared to firms owned by less well educated individuals. However, results are inconsistent (see e.g. Gudgin et al., 1979; Pickles and O´Farrell, 1987).

2.1.2 Innovation performance

Innovation resources are required to produce technological innovation, but are rarely sufficient on their own to assure commercial benefit. Intellectual property rights, patents and the launch of new products are major considerations in university-industry collaborative ventures. Patenting and paptens can be used as a measure of firm output, but for the majority of small firms undertaking R&D, the ultimate goal is the launch of new products. The typical development pattern for new firms is an initial heavy dependence on contract research and development activities. Innovation for most firms – small and large – is a top strategic priority. However, from a practical point of view there are difficulties related to measuring the actual impact of innovation on performance. For example, in a survey of senior managers performed by the Boston Consulting Group (BCG, 2007) it was found that very few companies track their innovation efforts and despite being aware of the importance of metrics and mesurement it was hard to find measures (BCG, 2007). The BCG study found that the majority of companies used a small number of metrics to measure their innovation activities and the most widely tracked components were profitability (82% of respondents); time to market (62%) and ideas generation (61%). Surprisingly, patents were not mentioned. Chiesa et al. (2001) in a conceptual piece of work propose a useful although very complex framework for measuring innovation performance and suggest some qualitative measures such as concept generation, product development effectiveness (typically time to market, product performance, design performance) technology aquistion, resourcing, etc. (Chiesa et al., 2003, p 115).

Romijn and Albaladejo (2002) explore the determinants of innovation capability in small UK electronics and software firms. They use an experimental innovation index alongside conventional proxies for innovation performance. Their indicators are correlated with variables capturing a range of potentially important internal sources, such as education, prior work experience and R&D effort, and measures of intensity of external interactions and proximity in network relations. Their findings support the importance of R&D, the key role played by the regional science base in nurturing high-tech spin-offs, and proximity to suppliers, but not the current policy fashion for encouraging regional networks revolving around firms in similar business activities and close customer relations. The present study does not point explicitly to R&D efforts as being the main capability required for innovation. Rather, it highlights *enabling* mechanisms connected with knowledge generation and knowledge absorption.

It could be argued, therefore, that innovation is related to the firm's overall results and business performance and can be measured using means such as profitability and market share, or for small firms, simply growth. One the other hand, innovation and innovation performance could be linked to dimensions related to the ability to introduce new products and services to the market, involving complex qualitative measures. It could also be argued that the problem is not what to measure, but how to organize measurement in a efficient and value creating manner, from both a practical and an academic point of view. There is a dearth of studies focusing on firm performance related to innovation. Also, very few studies deal with the role of capabilities for firm innovativeness or ability to innovate, and especially among very small firms.

2.2 Research proposition

The empirical evidence provided in this study is restricted to industries where (i) the technological environment is dynamic or hostile, (ii) perceived uncertainty is high, and (iii) as a result there is a need for new information. In such industries, technological innovations can be expected to range from dynamically continuous to discontinuous (Lin and Zaltman, 1973). The research proposition in this study relates specifically to the potential for innovation performance associated with innovation capabilities. In our study we use five innovation capability dimensions: Skills (work experience and education); Motivation drivers (attitudes and motivation of the firm’s founders and managers); Behaviour (strategic posture and attitudes); Business (basic dimensions of a firm´s business planning and perspective on the environment); and External networks (R&D and business networks). It is recognized generally that in technologically intensive industries, competitive firms need a set of core resources and core capabilities aside from the actual technology. Being innovative is not the same as being successful at commercialization, which implies the long term ability to deliver new knowledge, concepts and products to the market. In our study we are interested in investigating the relationship between capabilities for innovation and actual performance. Micro firms, both in incubators and outside of them, are perceived as ’very innovative’ and their good innovation performance we suggest is explained by the capabilities to innovate. Our research proposition is that:

The proposed dimensions of innovation capabilities in small firms have an influence on their innovation performance.

3. Method

3.1 Methodological design

This paper is based on a sample of 131 NTBF in Sweden and the data collection was undertaken in spring 2005. The firms in the sample were localized in 16 incubators and include small new and recently established firms. Incubators and related organisations are a relative novelty in Sweden. The first incubators were established in the 1980s. There is some evidence that incubators can promote industry renewal and growth. This has generated interest from the Swedish government in supporting this initiative. The Swedish National Incubator Program (NIP) includes 18 incubators which we used to make our selection of micro firms. We made our selection from only 16 of the 18 incubators because we judged to be more in the nature of firm 'hotels', i.e with no business support to the located firms. The study covered the following incubators: Inova, Science Park Jönköping, ProNova Science Park, Ideon Innovation, Gothia Business Incubator, Företagsinkubator Teknikdalen, Uppsala Innovation Centre, GU Holding, Karolinska Science Park, Mjärdevi, Uminova Innovation, Stockholm Innovation and Growth, Blekinge Business Incubator, SSE Business Lab, Chalmers Innovation and MINC, which hosted a total of 189 – mostly technology - firms. Defining what is and what is not high technology is problematic. We chose a definition based on Monck et al. (1988), that is, firms that are new knowledge-based, leading edge, and R&D intensive. The incubators host only independent, entrepreneurially managed firms.

3.2 Data collection and the sample

To identify the population and avoid defects of frame, we constructed the following control parameters: No longer in operation, wrong business (No R&D), bankrupt business, mergers and businesses with more than 50 employees. Questionnaires were administered to the small firms in the 16 incubators (respondent: manager/director) during the spring of 2005. After two written and one telephone reminder, we received responses from 133. We rejected two of these as invalid due to incomplete responses to the questionnaire. All measures in the questionnaire were on a five-point Likert-type scale, Yes=1, No=0 and %.

The branches used to classify the firms located in the incubator are software/information technology, technology consultants, electronics/electrical, pharmacology and pharmaceutical preparation, mechanics and industrial chemistry/plastics. Table 1 presents the broad characteristics of the firms involved. A total of 189 small high-tech firms was surveyed from which we recieved 131 valid responses, a response rate of 69%. Table 1 shows that most of the surveyed firms are new (mean 2.76 years). The tracking of firms inside Swedish incubators was successfully achieved due to the supplementary information regarding organisation name changes and/or organisation changes provided by incubator managers. Growth in this study is not analysed as a separate employment element (<3 years). However, expanding sales are central to a successful innovation process.

INSERT TABLE 1 ABOUT HERE

Questionnaires tend to be weak on validity and strong on reliability. The artificiality of the survey format reduces validity, which is related to the strength of the conclusions or propositions. Cook and Campbell (1979) define validity as the best available approximation to the truth or falsity of a given inference, proposition or conclusion. Since managers' perceptions are difficult to capture in terms of dichotomies such as "agree/disagree," "support/oppose," "like/dislike," or Likert scales (1-5) etc. The measures are only approximate indicators.

A common problem with self-reported data is the possible occurrence of common method bias. One solution to resolve this is to send out the questionnaire to two or more respondents in each firm and then extract the average, if the differences between the observation is not significant one might say that common method variance is not present. In our case we deal with very small firms and since there is usually only one person in a manager position, which makes this method unworkable. Our response rate is 69%, and is in line with guidelines on sample size, or minimum number of respondents necessary for a good result. We find different patterns regarding response rates from different incubators.

3.3 Construct for investigation and statistical analysis

3.3.1 Capabilities for innovation and innovation performance in small firms - variables

The tool for measuring *innovation capabilit*ies in this study was developed based in part on the dimensions of the capabilities used for large firms and in part on relevant dimensions typical of small firms. The choice of variables used to describe these dimensions is our own. The five dimensions and their related variables in our view represent the most important dimensions of the capabilities for innovation in very small (micro) firms (for an overview of all 41 variables, see Table 2).

Skills. Skills in micro firms generally refer to the work experience and education of the few employees (or sometimes the owner) and the extent to which these are or are not broad and multidisciplinary. It includes the skills gained through work experience (7 variables).

Motivations. The attitudes and motivation of the firm founders and managers is a key factor in the ability to raise funds and achieve high performance. Firm drivers are the underlying factors that motivate the firm and include such aspects as employment growth and profits (4 variables).

Behaviour. A firm’s strategic position can be established by a variable ranging from conservative to entrepreneurial. Conservative firms tend to be risk averse, non-innovative and reactive. Entrepreneurial firms tend to be risk takers, innovative and proactive. The dimension also includes attitude to competitors (3 variables).

Business. The variables in our study relate to several basic dimensions of the firm´s business planning and perspectives. These dimensions include business plans, investment planning, etc. and whether or not the firm uses business and investment plans (9 variables).

External networks. A network can be seen as a separate resource and through the network the firm acquires access to resources and capabilities such as advice. Two different types of networks are measured (13 variables).

The tool to measure *innovation performance* was designed to correspond to easily accessed measures for micro firms in particular. The range of questions in the overall survey was intended to provide an indication of the technological capability of firms. In the study for this paper, we use five variables to capture innovation performance more specifically: Patents; Copyright; Licences; Change in product portfolio in the previous three months; and New product introduction before competitors. Innovation performance includes the capabilities required to produce product developments. It is generally recognized that in technologically intensive industries, competitive firms need a set of core capabilities related to R&D along with other capabilities.

Table 2 presents the 41 variables used in this study including five dimensions for innovation capability and one dimension for innovation performance. All innovation performance measures are Yes/No (1/0) choices, and the innovation capability measures in most cases are based on 1-5 Likert scales or Yes/No answers.

INSERT TABLE 2 ABOUT HERE

3.3.2 Statistical analysis

For the analysis we used the Pearson correlation to predict initial factorability using visual examination to identify the variables (items) that are statistically significant (correlation is significant at the 0.05 level). The correlation analyses present the simple relationships among items (Pearson-correlation, -1–1). Among the correlations that are significant at the 0.01 or 0.05 level, several of the higher values stem from correlations between variables within the same group. The fact that many of the variables within the groups are highly correlated with each other indicates that the variables have been grouped appropriately. Our focus is on the relations between the five groupings for innovation capability: skills, motivations/drivers, behaviour, business, external networks, innovation performance. We computed regression analyses computed for the innovation capability variables with significant correlation to the innovation performance variables.

The next step was factor analysis. Factor analysis tests whether or not the variables selected to measure each construct exhibit sufficient convergent and discriminating validity. Factor analysis uses a principal component method and a varimax rotation. The varimax rotation is orthogonal, and is uncorrelated throughout the rotation process and produces theoretically meaningful factors. Factor loadings are considered significant for different sample sizes (Hair et al., 1995). In our case a sample size of 131 firms needs a factor loading exceeding 0.50-0.45 in order to be considered significant at the 0.05-level (Hair et al., 1995), which is sufficient for exploratory studies. The analysis involves estimation of the innovation capability measures and innovation performance variables using factor analysis, and tests whether or not the variables selected to measure each construct exhibit sufficient convergent and discriminatory validity. Factor analysis specifies the relations between the observed measures and their posited underlying constructs, where the constructs are allowed to intercorrelate freely. In general, most departures from previous factor-analytic findings appear to be attributable to small firms and the inclusion of additional variables (Child, 1972; Pugh et al., 1968; Reimann, 1973). To test the reliability of the latent constructs, we computed Cronbach´s alpha, using the more conservative value of 0.50 as the threshold value (Cohen, 1977). This is considered sufficient for exploratory studies (Hair et al., 1995).

Latent variables are variables that are not directly observed, but rather are inferred from other of the variables that are observed (directly measured). One advantage of using latent variables is that it reduces data dimensionality. Factor analysis searches for joint variations in response to unobserved latent variables. Latent variables, created using factor analytic methods, generally represent 'shared' variance, or the degree to which variables move together and are rather inferred from other observed (directly measured) variables. Variables that are not correlated cannot result in a latent construct based on the common factor model. A possible third step would be a structural equation modelling approach in which the linear relations of the latent constructs are more explicitly investigated. In this paper we identify only the underlying patterns and therefore chose not to perform this third step.

4. Empirical findings

This section reports the responses of the firms to questions about the variables, correlations, and regression analysis (Tables A-E in the Appendix) and presents the results of the factor analyses. The results of the factor analyses and Cronbach´s alpha are reported in Tables 5 and 6. Each variable is named and linked to a factor, that is, has a factor loading. Of the 36 variables, 26 have connections with one or several of the innovation performance dimensions and 17 of the innovation capability variables split into two factors.

We find that the innovation capabilities variables embedded in the five dimensions explain firm innovation performance (5 variables). Several interesting features emerge from the correlation analyses, regression analyses and factor analyses. Tables 3 and 4 report the Pearson correlations (*r*) between the significant variables, and show some strong correlations between the five innovation capability dimensions in the firm and performance measures. Tables 3 and 4 present the correlations and the variables to which they relate under the headings of the variables: skills, motivation drivers, behaviour, business networks, external networks and innovation performance.

INSERT TABLE 3 ABOUT HERE

INSERT TABLE 4 ABOUT HERE

It should be noted that the innovation performance measure ‘Patent’ correlates with up to 20 of the innovation capability variables. All five innovation capability dimensions are correlated to Patent and some of the variables have a negative effect on Patent. The firm variables that affect Patent negatively are Use of business plans, Long-term analyses of technology development, Common R&D-projects with university, Basic research-university, Applied research-university and Advice from consultants (6 out of 20 variables, see Appendix Table A). All these variables are located in the dimension External networks. The notion that networks are important in innovation, and that micro firms will build networks if they located in close proximity, seems to be partly contradicted by our study.

There are few connections between copyright and licences and the other variables. Copyright is affected by Long-term prognoses of selling, General development-university and Advice from banking institutions, all positively affected (see Table B in Appendix). The performance measure Licences is affected by only two innovation capability variables - Importance of work experience-selling (negative association) and Relation to competitors-cooperation or elimination (positive) (see Appendix Table C). The two ”product innovation” variables - Change in product portfolio in previous 3 months and New products before competitors - have correlations with 14 of the innovation capability variables.

‘Change in product portfolio in previous 3 months’ is positively affected by Education level - masters/bachelors, Other education-business and management, Firm start-importance of R&D-results (business), Relation to competitors-cooperation or elimination and Product prices-low-high (see Appendix Table D). New products before competitors is correlated to Other education-business and management, Firm start-importance of R&D-results (business), Importance of R&D, technology and innovation, Common R&D-projects with university, Advice from lawyers, Basic research-university and Communication with university personnel, with only the last having a negative effect the performance variable N (see Appendix Table E).

Table 5 reports the factor analysis for Cooperation with universities and Business planning and advice and 17 out of 26 variables are correlated (significant at 0.05-level) with one or several of the performance measures. Nine variables had factor loadings below 0.300 and are not included in the table. The variables can be split into two different factors - Factor 1 (latent construction), Cooperation with universities 9 variables, and Factor 2 (latent construction), Business planning and advice 8 variables.

INSERT TABLE 5 ABOUT HERE

Cronbach´s alphas for the latent constructs are 0.78 and 0.90 and exceed the minimum value of 0.50. The items are considered, therefore, to be reliable predictors of the latent construct. Micro firms in incubators mean that incubators offer firms an environment that supports R&D-network formation and offer operational management support for firms. Incubators are a particularly suitable location for new businesses, and opportunities exist for incubator managers to develop training and business placement programmes to assist the firms.

Table 6 presents the factor analysis of the innovation performance variables. The innovation performance measure consists of five variables, with Patents the only variable in factor 2. Patents are often used as an indicator of technological development, although the propensity to patent varies between sectors, firms and countries. The first factor, Product development, contains the other variables (Cronbach's alpha>0.50). The firms have quite high rates of innovation performance (see Table 2): nearly 43% of firms patent, nearly 24% hold copyrights and 11% are involved in licensing. The other innovation performance measures, Change in product portfolio in previous 3 months (71%) and New products before competitors (almost 44%) show quite high rates of innovation performance (the firms are only 2.8 years old)

INSERT TABLE 6 ABOUT HERE

The performance innovation measures fall into two latent constructs: Product development (licenes, copyrights and operative product development: Cronbach's alpha>0.50), and Patents (measure of patenting activity by firms). All variables have factor loadings above 0.30. The questions in the survey were intended to provide an indication of firms' innovation performance. Many firms employ qualified scientists (nearly 70% of the firms have employees with at least one PhD-degree).

5. Discussion

The objective of this paper is to describe and analyse dimensions critical to innovation performance for very small high-tech firms. We proposed that the chosen five dimensions for capabilities should be related to innovation performance in the special case of very small (micro) firms. We found 20 relationships between the innovation capabilities dimensions and innovation performance, but only 14 relationships between the innovation capabilities dimensions and the four innovation performance dimensions. The dimension Patents was strongly correlated to capabilities.

Patenting activity is often used to map aspects of innovation performance and the technological progress of countries, regions, certain specific domains and technology fields and firms. The use of patent statistics to monitor developments in the field of science has expanded and the roles of different types of innovation – patents, product development - are especially interesting. It is difficult to say whether patents is the most suitable performance indicator for micro firms or the most appropriate dimension to relate to capabilities. It has been argued that innovation performance is difficult to measure in terms of both finding an appropriate measure and finding the right metrics (BCG, 2007; Chiesa et al., 1996), and for small, newly established firms where measures such as market share, pace of product change are not feasible, patents are useful. According to Krammer (2009), patents present advantages and disadvantages, but in our case patents, copyrights and licenses are the best available measures of innovation based on availability and number to measure firm performance.

In the previous section, the empirical data and the statistical analysis were presented. The analysis examined the association between specific innovation capabilities variables and innovation performance according to the stated research proposition. The findings from this study confirm that the suggested innovation capabilities dimensions have an impact on innovation performance, particularly the dimension Patents.

The results of the Cronbach´s alpha test (reliability test) indicated a high degree of consistency for each of the factors in our study. The factor analysis for the innovation capabilities dimensions reveals two underlying constructs. That is, two dimensions of capabilities are important for micro firms' innovation performance: Cooperation with universities and Business planning and advice. The variables that are associated with Cooperation with universities are typical of knowledge generation - communication, knowledge transfer, information processing, R&D-equipment, basic and applied research etc. Research networks are important for identifying opportunities and testing new ideas, and collaboration with universities provides a means of developing technological knowledge and the capabilities that small firms lack to foster knowledge domains in-house. Further, universities and research centres can provide consulting assistance to new firms and opportunities for continuing education. Research collaborations can take many forms, from formal research contracts to informal contracts and exchanges of personnel between academia and industry (Quintas et al., 1992).

Our study shows that co-operation with universities is negatively related to Patents, one of the innovation performance dimensions. This might seem surprising, however, micro firms, located in incubators are generally very sensitive to commercial pressures and are not in a position, on their own, to undertake long-term R&D and business development which require financial resources. Small firms usually do not have separate R&D and business development departments and usually depend on a few key persons who are obliged to multi-task. In terms of knowledge absorption (e.g. Cohen and Levinthal, 1990), small firms face difficulties in exploiting the value from co-operation with universities. Firms with more internal resources can more easily absorb the knowledge and technologies co-operatively developed with universities. For small firms, these collaborations consume the resources of small firms. The problem is that academic basic research is too long-term to benefit innovative small firms with no long-term financial resources, and the universities are ill-equipped to respond to immediate problem-solving demanded by commercial competition, and do not take account of the fact that knowledge absorption differs between small and larger, more established firms. Some studies show that micro firms working with universities can benefit. Proximity between firms and universities promotes the exchange of ideas through formal and informal networks (Deeds et al*.,* 2000). Our study shows, however, that the capability to use external linkages, such as collaboration with universities, do not influence innovation performance positively, possibly due to lack of resources and poor absorptive capacity in small firms thus contradicting the assumpition for large firms (e.g. Unn et. Al, 2010).

Another interesting finding among the totally 6 variables that negatively affect the innovation capability dimension Patents – aside the various forms of university cooperation – are Use of business plans and Long-term analyses of technology development. These last two activities are in general considered being crucial for any R&D or Business Planning function in any large firm. However, there is an inherent risk that these capabilities are not dynamic and may not be able to respond to market changes but instead can become rigidities (Leonard-Barton, 1992). Our results show that these activities contradict the innovation performance dimension Patents, and could be interpreted as showing that the necessary capability for being innovative not at all lies in planning efforts whether business or technology. Rather, adaptation to new markets, and being able to make rapid changes are more important.

Since small firms see patents and new products as opportunities to increase revenues and achieve competitive advantage, competition over these rights is often contentious (Phillips, 1991). This supports the finding that Patents is an appropriate innovation performance indicator for small firms. A firm´s external networks, in our study R&D networks and Business networks, seem to be major contributors to the firm´s innovation performance, both directly in terms of possible knowledge absorption and indirectly in terms of attractiveness. The firm´s ability to mobilize resources, attract researchers at the universities, attract financial resources. Identifying entrepreneurial opportunities also depends on the firm's external networks and social relations.

Our second underlying construct, Business planning and advice, refers to the firm´s business planning and business network. The firms in our study are very small and have few resources for businness planning and business analysis; they rely on the incubators for these services. For larger firms, these activities are taken for granted in the management of the firm and do not always promote innovativeness; for small firms they are directly related to innovation performance. The micro firm context is characterized by a complex and dynamic environment, including high technology, product/service changes due to intense competition, and activities aimed at advice and support which are crucial for understanding the market context.

This study has several limitations in addition to the limitations typical of survey research. The incompleteness of the set of innovation capabilities variables is a central one, especially in light of the established frameworks for understanding capabilities in large firms. There is a need to develop relevant and easily measured measures for small firm innovation capabilities and this study with its construct for investigation serves as a contribution to that. Also, the measures used for innovation performance are simplifications compared to reality, but in our view they reflect performance and enable us to identify the relationships with certain capabilities. From a change-based perspective, the aim is not to measure innovation performance per se but to measure its relationship to certain capabilities.

6. Conclusions

In this paper we show that it is possible to design a simple construct for investigating the innovation capabilities of micro firms, for innovation and their relation to innovation performance using metrics that are easily monitored. Our study shows that building capabilities for innovation, can be grouped into Co-operation with Universities and Business Networks, that is, these two groups of capabilities are the most important for innovation performance, but in different directions. The variables chosen to measure innovation performance – New products before competitors, Patents, Licenses, Copyrights and Change in product portfolio last three months – fall into two categories based on the factor analyses where Patents is the only variable in one of the groups. Patents is the variable with the strongest relation to all the measured capabilities for innovation. We thus show that there is a significant influence on innovation performance of the dimensions chosen for our construct. Further, innovation performance can be argued to be positively influnced by the latent constructs Cooperation with universities and Business planning and advice. The necessary capabilities required seem to be drive and enthusiasm and a good level of education. Our study shows that the capability to use external linkages, such as collaboration with universities, does not influence innovation performance in small firms positively due to their lack of resources and lack of absorptive capacity, which contradicts the assumpition for large firms. The micro firms in our study are too small to benefit from open innovation notions such as complementary knowledge and additional perspectives capabilities that they though are crucial for innovation.

This paper contributes to the literature on the capabilities for innovation in two ways. First, we address the key notion of relating capabilities to innovation performance measures and propose a model. Second, we address the notion of capabilities especially for micro firms, while ; research around organizational capabilities in their various forms has mostly focused on the large firm perspective. Both areas require more research.

Appendix

A. Regression analyses.

Table A

Model[abc]	Standardized Coefficients, Beta	t	Sig.	Corr[d]
(Constant)		-1,960	.053	
Education level-Ph D	.186	2.024	.046*	.292**
Firm start–import. of R&D-results, univ.	.006	.056	.955	.333**
Importance of sales growth	.026	.341	.734	.180*
Importance of growth of profits	.124	1.577	.118	.204*
Importance of R&D, technology and innovation	.113	1.272	.206	.380**
The firm follows competitors-market leaders	.110	1.347	.181	.307**
Use of business plans	-.075	-,781	.437	.252**
Investment planning	.075	.845	.400	.228**
Long-term analyses of technology devel.	-.216	-1.977	.051	.249**
Studies of customers	.068	.717	.475	.227**
Common R&D-projects with univ.	-.044	-.337	.737	.277**
Communication with univ. Personnel	.021	.173	.863	.259**
Transfer of R&D-documents-univ.	.012	.083	.934	.233**
Use of R&D-equipment-univ.	.225	1.933	.056	.451**
Basic research-univ.	-.025	-.233	.816	.190*
Applied research-univ.	-.166	-1.166	.246	.259**
General development-univ.	.058	.484	.629	.271**
Advice from consultants	-.079	-.878	.382	.264**
Advice from lawyers	-074	.904	.368	.359**
Advice from patenting bureau	.530	5.131	.000**	.645**

Notes:
[a] Dependent variable: Patent.
[b] Model summary: R=.727, adjusted R square=.529 and standard error of estimate=.36856.
[c] The model: Sig.= .000** (ANOVA)
[d] Correlations between dependent variable and the independent variables.
* p<0.05
** p<0.01
*** p<0.005

Table B

Model[abc]	Standardized Coefficients, Beta	t	Sig.	Corr[d]
(Constant)		-.503	.616	
Long-term prognoses of selling	.133	1.470	.144	.187*

General development-univ.	.156	1.767	.080	.180*
Advice from banking inst.	.153	1.705	.091	.193*

Notes: [a] Dependent variable: Copyright.
[b] Model summary: R=.284, adjusted R square=.080 and standard error of estimate=.41747.
[c] The model: Sig.= .018* (ANOVA)
[d] Correlations between dependent variable and the independent variables.
* p<0.05
** p<0.01
*** p<0.005

Table C

Model[abc]	Standardized Coefficients, Beta	t	Sig.	Corr[d]
(Constant)		.755	.452	
Importance of work experience-selling	-.179	-2.037	.044*	-.179*
Relation to competitors-cooperation or elimin.	.209	2.379	.019*	.191*

Notes: [a] Dependent variable: Licenses.
[b] Model summary: R=.275, adjusted R square=.076 and standard error of estimate=.30911.
[c] The model: Sig.= .009** (ANOVA)
[d] Correlations between dependent variable and the independent variables.
* p<0.05
** p<0.01
*** p<0.005

Table D

Model[abc]	Standardized Coefficients, Beta	t	Sig.	Corr[d]
(Constant)		.608	.544	
Education level-Master/Bachelor	.141	1.681	.095	.189*
Other education – business and management	.178	2.103	.038*	.202*
Firm start-importance of R&D-results, business	.163	1,940	.055	.177*
Relation to competitors-cooperation or elimin.	.179	2.109	.037*	.191*
Product prices - low – high	.173	2.024	.045*	.217*

Notes: [a] Dependent variable: Change in products last 3 months.
[b] Model summary: R=.411, adjusted R square=.169 and standard error of estimate=42551.
[c] The model: Sig.= .000** (ANOVA)
[d] Correlations between dependent variable and the independent variables.
* p<0.05
** p<0.01
*** p<0.005

Table E

Model[abc]	Standardized Coefficients, Beta	t	Sig.	Corr[d]
(Constant)		-.663	.508	
Other education – business and management	.279	3.177	.002**	.287**
Firm start-importance of R&D-results, business	.111	1.268	.207	.190*
Importance of R&D, technology and innovation	.095	1.028	.306	.221*
Common R&D-projects with univ.	.118	.871	.385	.188*
Communication with univ. personnel	-.059	-.469	.640	.195*
Basic research-univ.	.112	.957	.341	.191*
Advice from lawyers	.148	1.701	.092	.183*

Notes:
a Dependent variable: New products before competitors.
b Model summary: R=.436, adjusted R square=.141 and standard error of estimate=.46228.
c The model: Sig.= .001** (ANOVA)
d Correlations between dependent variable and the independent variables.
* $p<0.05$
** $p<0.01$
*** $p<0.005$

References

Ackroyd, S.(1995). On the structure and dynamics of some small, UK-based information technology firms. *Journal of Management Studies*, 32(2), 141-161.

Aerts, K., Matthyssens, P. and Vandenbemt, K. (2007). Critical role and screening practices of European business incubators. *Technovation*, 27,(5), 254-267.

Assink, M. (2006). The inhibitors of disruptive innovation capability: a conceptual model. *European Journal of Innovation Management*, 9(2), 215-233.

Barney, J.B. (1991). Firm Resources and Sustained Competitive Advantage. *Journal of Management*, 17(1), 99-120.

Bergek, A. and Norrman, C. (2008). Incubator best practice: A framework. *Technovation*, 28, (1-2), 20-28.

BCG, (2007). *Measuring Innovation 2007 – A BCG Senior Management Survey*, The Boston Consulting Group Report, Boston.

Birley, S., 1985, The role of networks in the entrepreneurial process*. Journal of Business Venturing*, 1, 107-117.

Borch, O. J., Huse, M. and Senneseth, K., 1999, Resorce configuration, competitive strategies and corporate entrepreneurship: an empirical examination of small firms. *Entrepreneurship Theory and Practice*, 24(1), 49-70.

Chan, K.F. and and Lau, T.(2005). Assessing technology incubator programs in the science park: the good, the bad and the ugly. *Technovation*, 25(10), 1215-1228.

Chiesa, V., Coughlan, P. and Voss, C. (1996). Development of a Technical Innovation Audit", *Journal of Product Innovation Management,* 13 (2),105-136.

Child, J. (1972). Organizational structure and strategies of control: A replication of the Aston study. *Administrative Science Quarterly*, 17, 163-177.

Christensen, C.M. (1997). *The innovator's dilemma*, Harvard Business Review Press, Boston.

Cohen, W.M. and Levinthal, D.A. (1990). Absorptive Capacity: A New Perspective on Learning and Innovation. *Administrative Science Quarterly*, 35, 128-152.

Colarelli O'Connor, G. (2008). Major innovation as a Dynamic Capability: A systems approach. *Journal of Product Innovation Management*, 25(4), 313-330.

Colarelli O'Connor G., Paulson A.S. and DeMartino, R. (2008). Organisational approaches to building a radical innovation dynamic capability. *International Journal of Technology Management*, 44(1/2), 179-204.

Coff, R. W. (1997). Human assets and management dilemmas: coping with hazards on the road to resource-based theory. *Academy of Management Review*, 22(2), 374-402.

Cook, T.D. and Campbell, D.T. (1979). *Quasi-Experimentation: Design and Analysis for Field Settings*. Rand McNally, Chicago, Illinois.

CSES (Centre for Strategy & Evaluation Services) (2002). *Final Report Benchmarking of Business Incubators*, European Commission Enterprise Directorate-General, Brussels.

Daft, R. (1983). *Organization theory and design.* West, New York.

Das, T. K. and Teng, B-S. (1997). Time and entrepreneurial risk behavior. *Entrepreneurship Theory and Practice*, 22(2), 69-88.

Deeds, D. Decarolis, D. L. and Coombs, J. E. (2000). The determinants of research productivity in high technology ventures: an empirical analysis of new biotechnology firms. *Journal of Business Venturing*, 15(2), 211-229.

Eisenhardt, K.M. and Martin, J. (2000). Dynamic Capabilities: What are they?, *Strategic Management Journal*, 21(10/11), 1105-1121.

Grant, R. (1996). Towards a knowledge based theory of the firm, *Strategic Management Journal,* 17(winter special issue), 109-122.

Gudgin, G., Fothergill, S. and Brunskill, I. (1979). New manufacturing firms in regional employment growth*. Centre for Environmental Studies, Research Series*, 39 (Nov), London.

Hair, J.F. Jr, Anderson, R.E., Tatham, R.L., Black, W.C. (1995). Multivariate Data Analysis with Readings. NJ, 4th edn, Prentice Hall: Upper Saddle River.

Helfat, C.E., Finkelstein, S., Mitchell, W., Peteraf, M.A., Singh H., Teece, D.J. and Winter, S. (2007). *Dynamic Capabilities, Understanding strategic change in organizations,* Blackwell Publishing, Singapore.

Helfat, C.E. and Peteraf, M.A., 2003, The dynamic resource-based view: Capability lifecycles. *Strategic Management Journal*, 24(10), 997-1010.

Henderson, R. and Cockburn, I, (1994). Measuring competence? Exploring firm effects in pharmaceutical research. *Strategic Management Journal*, 15(1), 63-84.

Krammer, S.M.S. (2009). Drivers of national innovation in transition: evidence from a panel of Eastern European countries. *Research Policy*, 38(5), 845-860.

Leonard-Barton, D. (1992). Core capabilities and core rigidities: a paradox in managing new product development. *Strategic Management Journal*, 13(1), 111-125.

Lin, N. and Zaltman, G. (1973) Dimensions of innovations. In Zaltman, G. (Ed), *Processes and Phenomena of social change*. Wiley, New York, pp. 93-115.

Lindström, G. and Olofsson, C. (2001) Early stage financing of NTBFs: an analysis of contributions from support actors, *Venture Capital*, 3(2), 151-168.

Little, A.D. (1979). *New technology-based firms in the UK and Federal Republic of Germany*, Wilton House Publications, London.

Nasyak, A. and Greenfield, S. (1994). The use of management accounting information for managing micro businesses, in A. Hughes, D. J. Storey (eds). *Finance and the small firm*. London, Routledge.

Nonaka, I. and Kenney, M. (1991). Towards a new theory of innovation management: A case study comparing Conon, Inc. and Apple Computer Inc. *Journal of Engineering and Technology Management*, 8, 67-83.

Penrose, E.T.,1959, *The Theory of the Growth of the Firm*, Wiley, New York.

Penrose, E. T. (1960). The Growth of the Firm. A Case Study: The Hercules Powder Company. *Business History Review*, 34(1), 1-23.

Phillips, D. (1991). New alliances for policy and the conduct of research and education. *International Journal of Technology Management*, 6(5/6), 478-487.

Pickles, A.R. and O´Farrell, P.N. (1987). An analysis of entrepreneurial behaviour from male work histories. *Regional Studies*, 21(5), 425-444.

Prahalad, C.K. and Hamel, G. (1990). The Core Competence of the Corporation. *Harvard Business Review*, 68(3), 79-91

Pugh, D., Hickson, D. J. and Hinings, C. R. (1968). Dimensions of organizational structure. *Administrative Science Quarterly*, 13, 65-105.

Quintas, P., Wield, D. and Massey, D. (1992). Academic-industry links and innovation: questioning the science park model. *Technovation*, 12(3), 161-175.

Reimann, B. (1973). On the dimensions of bureaucratic structure: An empirical reappraisal. *Administrative Science Quarterly*, 18, 462-476.

Romijn, H. and Albaladejo, M. (2002). Determinants of innovation capability in small electronics and software firms in southeast England. *Research Policy*, 31(7), 1053-1067.

SiSP 2007, *Medlemskriterier*, Available at: http://www.sisp.se/default.asp?webbsida_ID=26&u1=126.

Teece, D. J. (1986). Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. *Research Policy*, 15(6), 285-305.

Teece, D. J. (1989). Inter-organizational requirements of the innovation process. *Managerial and Decision Economics*, Special Issue, 35-42.

Teece, D. J. (2007). Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal*, 28(13), 1319-1350.

Teece, D.J., Pisano, G. and Shuen, A. (1997). Dynamic Capabilities and Strategic Management. *Strategic Management Journal*, 18(7), 509-533.

Tyler, B. B. (2001). The complementary of cooperative and technological competencies: a resource-based perspective. *Journal of Engineering and Technology Management*, 18(1), 1-27.

Unn, C.A., Cuervo-Cazurra, A. and Asakawa, K., (2010). R&D Collaborations and Product Innovation. *Journal of Product Innovation Management,* 27, 673-689..

Uzzi, B. (1996). The source and consequences of embeddness for the economic performance of organizations: the network effect. *American Sociological Review* (August), 61, 674-698.

Uzzi, B. (1997). Social structure and competition in inter firm networks: the paradox of embeddedness*. Administrative Science Quarterly*, 42, 35-67.

Van der Auwera, F., and Eysenbrandts, D. (1989). High tech firms in Flanders. BBM, Brussels.

Wernerfelt, B. (1984). A Resource-Based View of the Firm. *Strategic Management Journal*

Zollo, M., and Winter, S. (1999). From *Organizational Routines to Dynamic Capabilities*. Working paper, R. H. J. Center, Wharton School, University of Pennsylvania.

Zollo, M. and Winter, S.G. (2002). Deliberate learning and the Evolution of Dynamic Capabilities. *Organization Science*, 13, 339-351.

Zukin, S. and DiMaggio, P. J. (1990). *Structure of Capital* (Eds). Cambridge University Press, Cambridge, UK.

Table 1 Means and frequencies of surveyed firms located in 16 incubators.

1. Response rate

N (population)	189
n (response)	133
No valid firms	2
Response rate (%)	69.3

2. Performance measures – Means and standard deviations

	N	Mean	Std
Sales[1] 2004	105	1 679 226	7 533 985
Sales[1] 2003	101	947 750	6 841 668
Sales[1] 2002	100	718 800	5 069 885
Growth[3] (%): 54.5			
Employment 2004	108	2.07	4.10
Enployment 2003	104	1.06	3.41
Employment 2002	98	0.84	3.35
Growth (%): 60.0			

3. Firm age - Means and frequencies:

	Total population			Response		
	Mean	Std	Median	Mean	Std	Median
Age	3.59	2.40	3.0	2.76	1.93	2.0

4. Branch – frequencies (%)	Total population	Response
Software/information technology	35.10	41.90
Technology consultants	18.30	14.00
Electronics/electrical	6.90	5.60
Pharmacology and pharmaceutical preparation	16.80	17.70
Mechanics	9.90	10.50
Other	13.00	10.30
Sum	100.00	100.00

Notes: [1] SEK (Swedish crowns).
[2] Number of employees.

Table 2 Means and standard devations for the variables.

Variable	*Mean*	*Std*	*Scale*
Skills			
Education level-Ph D	0.692	1.646	Number
Education level-master/bachelor	2.412	2.887	Number
Other education – business and management	0.546	0.500	1/0 (Yes/No)
Work experience-business	0.741	0.440	1/0 (Yes/No)
Importance of work experience-selling	3.055	1.662	1-5
Firm start–importance of R&D-results, univ.	2.702	1.753	1-5
Firm start-importance of R&D-results, business	2.706	1.434	1-5
Motivation drivers			
Importance of sales growth	4.661	0.688	1-5
Importance of growth of profits	3.931	0.974	1-5
Importance of growth of employment	2.908	1.060	1-5
Importance of R&D, technology and innovation	3.862	1.340	1-5
Behaviour			
The firm is conservative-focus on growth/R&D	4.390	1.012	1-5
The firm follows competitors-market leaders	3.817	1.122	1-5
Relation to competitors-cooperation or elimin.	2.670	1.177	1-5
Business			
Use of business plans	3.171	1.364	1-5
Long-term prognoses of selling	2.504	1.306	1-5
Long-term prognoses of market devel.	2.411	1.272	1-5
Studies of competitors	3.023	1.320	1-5
Marketing studies	2.302	1.196	1-5
Investment planning	2.382	1.249	1-5
Long-term analyses of technology devel.	2.389	1.368	1-5
Studies of customers	3.542	1.360	1-5
Product prices - low – high	2.603	1.155	1-5
External networks			
Common R&D-projects with univ.	1.687	1.447	1-5
Communication with univ. personnel	2.214	1.622	1-5
Transfer of R&D-documents-univ.	1.489	1.297	1-5
Use of R&D-equipment-univ.	1.931	1.642	1-5
Basic research-univ.	1.520	1.318	1-5
Applied research-univ.	1.725	1.420	1-5
General development-univ.	1.800	1.416	1-5
Advice from banking inst.	1.550	1.068	1-5
Advice from chamber of commerce	0.657	0.892	1-5
Advice from consultants	2.160	1.640	1-5
Advice from lawyers	1.741	1.582	1-5
Advice from regional dev. Funds	1.137	1.352	1-5
Advice from patenting bureau	2.038	1.666	1-5
Innovation performance			
Patents	0.414	0.494	1/0 (Yes/No)
Copyrights	0.236	0.426	1/0 (Yes/No)
Licenses	0.111	0.316	1/0 (Yes/No)
Change in product portfolio previous 3 months	0.711	0.455	1/0 (Yes/No)
New products before competitors	0.438	0.498	1/0 (Yes/No)

Table 5 Factor analysis[abc]: Innovation capabilities variables divided into two factors.

Factors	1.	2.
Factor names	Cooperation with universities (α^d = 0.784)	Business planning and advice (α^d = 0.895)
Applied research-university[c]	.839	
Common R&D-projects with university	.827	
Transfer of R&D-documents-university	.823	
Communication with university personnel	.813	
General development-university	.806	
Use of R&D-equipment-university	.801	
Firm start-importance of R&D-results, university	.610	
Importance of R&D, technology and innovation	.387	
Education level-Ph D	.374	
Use of business plans		.636
Studies of competitors		.613
Long-term prognoses of selling		.600
Long-term analyses of technology development		.599
Investment planning		.556
Advice from patenting bureau		.456
Advice from consultants		.414
The firm follows competitors-market leaders		.323

Notes: [a] = Rotated factor matrix.
[b] = Factor loadings below 0.300 are not included in the table.
[c] = Cumulative variance is 48.57%.
[d] = α (Cronbach α) > 0.50.

Table 6 Factor analysis[abc]: Innovation performance variables divided into two factors.

Factors	1.	2.
Factor names	Product development (α^d = .586)	Patent (α^e)
New products before competitors	.679	
Copyrights	.527	
Licenses	.438	
Change in prod. portfolio previous 3 months	.434	
Patents		.575

Notes: [a] = Rotated factor matrix.
[b] = Factor loadings below 0.300 are not included in the table.
[c] = Cumulative variance is 29.97%.
[d] = α (Cronbach α) > 0.50.
[e] = Only one variable.

Table 3 Correlation matrix. Skills, Motivation drivers, Behaviour and Innovation performance.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.
Skills																		
1. Education level–Ph D																		
2. Education level–master/bachelor	-.082																	
3. Other education – business and management	-.059	.016																
4. Work experience–business	.091	.139	.020															
5. Importance of work experience–selling	.100	-.041	-.012	.255**														
6. Firm start–importance of R&D-results, university	.460**	.002	.190*	.079	-.043													
7. Firm start-importance of R&D-results, business	.018	-.019	.135	.056	.195*	.040												
Motivation drivers																		
8. Importance of sales growth	.076	-.052	-.048	.047	.015	.177*	-.002											
9. Importance of growth of profits	.087	.019	.102	-.023	-.040	.138	.082	.277**										
10. Importance of growth of employment	-.105	.015	.140	.016	.067	.224*	.102	.021	.046									
11. Importance of R&D, technology and innovation	.178*	.025	.143	.138	.055	.445**	.228**	.033	.058	.144								
Behaviour																		
12. The firm is conservative-focus on growth/R&D	.081	-.026	.087	.090	.006	.144	-.005	.266**	.027	-.053	.308**							
13. The firm follows competitors-market leaders	.032	-.031	.063	.012	.002	.136	.052	.132	.091	.014	.338**	.389**						
14. Relation to competitors-cooperation or elimination	-.076	.058	-.046	.056	-.006	-.062	-.048	-.135	.012	-.096	.053	.068	.222*					
Innovation performance																		
15. Patents	.292**	-.008	-.027	.169	-.097	.333**	.018	.180*	.204*	.017	.380**	.108	.307**	.030				
16. Copyrights	.040	.070	.060	-.093	-.135	.131	.048	.004	.017	.028	.160	-.001	.042	-.042	.027			
17. Licenses	-.060	.072	.031	-.026	-.179*	.083	-.055	.098	-.108	.053	.143	.135	.117	.191*	.063	.227*		
18. Change in product portfolio previous 3 months	-.155	.189*	.202*	.058	.055	-.124	.177*	-.036	.030	.100	.083	.054	-.048	.191*	-.080	.189*	.226*	
19. New products before competitors	-.088	.163	.287**	-.004	-.015	.002	.190*	-.009	-.025	.100	.221*	-.038	.127	.104	-.074	.390**	.265**	.286**

Notes: ** = Correlation is significant (0.01-level), 2-tailed, * = Correlation is significant (0.05-level), 2-tailed.

Table 4 **Correlation matrix.** Business, External networks and Innovation performance.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.
Business																										
1. Use of business plans																										
2. Long-term prognoses of selling	.460**																									
3. Long-term prognoses of market dev.	.499**	.442**																								
4. Studies of competitors	.371**	.397**	.450**																							
5. Marketing studies	.279**	.302**	.400**	.431**																						
6. Investment planning	.405**	.390**	.426**	.329**	.195*																					
7. Long-term analyses of technology dev.	.438**	.318**	.418**	.518**	.350**	.489**																				
8. Studies of customers	.234**	.195*	.314**	.429**	.379**	.135	.564**																			
9. Product prices – low – high	.101	.216*	.184*	-.009	.167	.037	.060	.251**																		
External networks																										
10. Common R&D-projects with univ.	.274**	.114	.122	.089	.170	.224	.326**	.177*	-.029																	
11. Communication with univ. personnel	.380**	.172	.187*	.052	.200*	.237**	.267**	.195*	.054	.658**																
12. Transfer of R&D-documents-univ.	.435**	.049	.257**	.120	.188*	.302**	.356*	.219*	-.065	.709**	.670**															
13. Use of R&D-equipment-univ.	.386**	.143	.323**	.130	.139	.249**	.358**	.275**	.136	.635**	.693**	.652**														
14. Basic research-univ.	.214*	.049	.088	.045	.253**	.257**	.336**	.272**	.011	.620**	.606**	.617**	.559**													
15. Applied research-univ.	.400**	.177*	.271**	.199	.216*	.259*	.357**	.253**	.088	.662**	.710**	.750**	.655**	.654**												
16. General development-univ.	.305**	.144	.177*	.098	.257**	.172	.226**	.176*	.016	.739**	.633**	.608**	.610**	.525**	.692**											
17. Advice from banking inst.	.057	.204*	.094	.024	.099	.153	.037	-.095	-.115	.117	.220*	.093	.044	.050	.045	.019										
18. Advice from chamber of commerce	.049	.131	.051	.053	-.083	.236**	.173*	.021	-.029	.137	.136	.106	.000	.055	.065	.069	.248**									
19. Advice from consultants	.478**	.291**	.192*	.071	.035	.312**	.219*	.195*	.135	.336**	.343**	.252**	.270**	.296**	.273**	.236**	.107	.169								
20. Advice from lawyers	.205*	.358**	.116	.215*	.112	.237**	.193*	.130	-.044	.173	.202*	.104	. 192*	.136	.153	.148	.263**	.242**	.245**							
21. Advice from regional dev. funds	.227**	.135	.140	.121	.220*	.087	.295**	.060	.020	.152	.162	.124	.153	.097	.144	.193*	.096	.314**	.118	.175*						
22. Advice from patenting bureau	.432**	.208*	.291**	.211*	.062	.340**	.463**	.228**	.028	.346**	.247**	.326**	.448**	.305**	.304**	.251**	-.055	.092	.440**	.465**	.247**					
Innovation performance																										
23. Patents	.252**	.128	.129	.141	.065	.228**	.249**	.227**	-.004	,277**	259**	.233**	.451**	.190*	.258**	.271**	-.124	-.011	.264**	.359**	.025	.645**				
24. Copyrights	.031	.187*	-.040	.129	.113	.047	.013	-.021	-.031	.096	.139	-.033	.021	.055	.089	.180*	.193*	-.002	.037	.002	.010.	-.025	.027			
25. Licenses	-.007	-.056	.020	.052	-.054	-.011	.043	.100	.056	-.039	.009	-.006	.064	.062	-.046	-,117	.031	.044	-.073	.152	.091	.015	.063	.227*		
26. Change in prod. portf. prev. 3 months	.085	.047	-.109	.103	.072	-.045	-.012	.088	.217*	.051	-.003	-.056	-.092	.046	-.052	.019	.057	.107	.013	.006	-.027	-.080	-.080	.189*	.226*	
27. New products before competitors	.022	.169	-.097	.105	.022	.002	.013	.088	-.131	.188*	.195*	.080	.021	.191*	.166	.118	.087	.110	.118	.183*	-.028	-.018	-.074	.390**	.265**	.286**

Notes: ** = Correlation is significant (0.01-level), 2-tailed, * = Correlation is significant (0.05-level), 2-tailed.