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Do organisational and spatial proximity impact on firm performance?[1]

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Abstract

Recent theoretical developments in organisation science, economic geography, and regional economics have emphasised the importance of organisational and geographical proximity for the performance of firms. Empirical evidence on these relationships is scarce, though. In this paper, we ask to what extent firm-specific resources, network activity, proximity, and industry factors influence innovative and economic outcomes. We used a theoretical synthesis of regional and organisational science, and economic geography to build a research model that enabled us to derive several hypotheses on the influence of different forms of proximity on outcomes, taking other relevant predictors for performance into account. Our empirical findings specify the importance of proximity especially for innovative outcomes. We found that in particular intra- and inter-regional relations with buyers and suppliers are conducive for firm performance. Moreover, innovation strategy (dis)similarity has interesting effects on relative firm performance. Finally, sectoral R&D spillovers influence outcomes in a positive way.

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INTRODUCTION

In recent years, a growing body of research in regional and organisational science has focused on inter-organisational networks, innovation and proximity. In this research, several theoretical frameworks are used. Some refer to old theoretical approaches like the Marshallian industrial district and externalities (BECATTINI, 1989), and some refer to more recent developments like R&D spillovers (AUDRETSCH AND FELDMAN, 1996), 'innovative milieux' (MAILLAT, 1991), 'New Industrial Spaces' (STORPER, 1997), the network approach (FISHER, 1999), and the literature on national and regional systems of innovation (LUNDVALL, 1992; GREGERSEN AND JOHNSON, 1997; MORGAN, 1997).

In a discussion and evaluation of these approaches, OERLEMANS ET AL. (2000) conclude that there is a general agreement on the importance of spatial proximity for innovation, although the models suffer from conceptual ambiguity (see also: MOULEART AND SEKIA, 2003). Territorial closeness to organisations in the same and related industries affects the ability to receive and transfer knowledge and encourages risk taking and sharing. Firms' innovation processes are presumed to benefit more from regional than from non-regional linkages, all else equal. However, there is little consensus as to how and why this occurs (AUDRETSCH, 1998).

Moreover, these literatures tend to theoretically underspecify what we call the proximity effect, i.e. profiting from localised networks. They do not clearly specify the theoretical mechanisms explaining the comparative advantages and outcomes of regional as compared to non-regional links (see also BRESCHI AND LISSONI, 2001). Empirical studies have been limited by the tendency to focus on successful networks and districts (STABER, 2001) in which proximity is a defining feature of a district or network instead of a variable of interest on its own. Moreover, empirical evidence on the importance of proximity for innovation and (innovative) outcomes is not conclusive. Some scholars find that spatial proximity matters

(MAKUN AND MACPHERSON, 1997; FRITSCH, 2001), while others find the opposite (GROTZ AND BRAUN, 1997; SMITH ET AL, 2002). From a methodological point of view, empirical studies have tended to apply descriptive or discursive rather than statistical approaches (LOVE AND ROPER, 2001). Consequently, the evaluation of the relative importance of factors that differentiate successful and unsuccessful firms and regions becomes a difficult task.

Besides spatial proximity, other forms of proximity have been distinguished in literature. For example, a study of strategic and organisational change in two major Swiss pharmaceutical companies (ZELLER, 2002) showed that cultural proximity (i.e., members of an organisational field sharing comparable norms and values) eases knowledge flows within and between firms. NOOTEBOOM (1999) used the concept of cognitive proximity to indicate the 'distance' between internal knowledge bases of organisations, larger cognitive distances between knowledge bases having the advantage of novelty and non-redundancy. Another form of proximity is organisational proximity (FILIPPI AND TORRE, 2003), which refers to a set of implicit or explicit routines, which allows individuals to be coordinated without having to define relevant behaviour beforehand. These different forms of proximity tend to be interrelated in intricate ways. Cognitive and spatial proximity, for example, tend to have an inverse relationship (FREEL, 2003), whereas cultural and spatial proximity are assumed to have a positive relationship (CAPELLO, 1999).

Our object in this paper is therefore to penetrate the black box of geographical space and to unravel the effects of proximity in innovation networks on innovative and economic performance taking aspects of organisational proximity into account. An important question is how to model the proximity effect: as an one factor model in which proximity is represented as a direct distance decay function of knowledge transfer or as a model showing the proximity effect in combination with dominant predictors for innovative and economic performance with several proxies for distance (users, suppliers, regional R&D). In this paper, we followed the approach to model innovative and economic performance as a function of the relative strength of the firms' internal resource base, the externally acquired resources (innovative ties with a variety of actors), the regional and sectoral R&D intensity (measuring the extent in which firms can benefit from regional and sectoral knowledge stocks), and the geographical distance between important buyers and suppliers (which is the most direct measure of the proximity effect). Linking a resource based argument (internal and external resources) with a proximity based argument (using three distinct proxies) results in an interesting model.

This approach enables us to contribute to an ongoing discussion in the field of inter-organisational relations. In a literature review of 158 studies on inter-organisational relations and networks, OLIVER AND EBERS (1998) conclude that research has centred on the driving forces behind inter-organisational networking, rather than on the possible consequences of networking. As a recommendation for future research, they state, "we need more comparative research that spells out regional or industry dimensions that could make a difference for networking and its outcomes" (OLIVER AND EBERS, 1998: 567). By studying the effects of (geographical) networks and sector-specific characteristics on innovative and economic outcomes, we add to this discussion.

Moreover, we add to the empirical evidence in the regional sciences on the effects of geographical proximity on the performance of innovative firms. Recently, a generally accepted hypothesis in the analysis of geographical interaction was put under closer examination (see for example: ASHEIM, 1999; RALLET AND TORRE, 1999; STERNBERG AND ARNDT, 2001; FREEL 2003). The received wisdom was that actors involved in innovation need to be physically close to one another since tacit knowledge transfer implies frequent face-to-face relationships. Firms having such physically close relationships are assumed to innovate with better results. Research shows, however, that this relationship is more complex. For instance, RALLET AND TORRE (1999) show that other types of coordination (like organisational proximity) can also provide the advantages of geographical proximity. Furthermore, FREEL (2003) points at the effects of firm size (smaller firms are more likely to be locally embedded) and the nature of the innovations (firms with novel innovations operate on a higher spatial scale), whereas STERNBERG AND ARNDT (2001) argue that patterns of spatial interaction differ between sectors. In this paper, we focus not only on the effects of proximity on innovative performance. The fact that firms are located in different regions with differing conditions and are a part of different sectors with varying innovative traditions is also taken into account. This enables us to specify and evaluate the relative importance of each of these factors in the explanation of innovative and economic performance using competing measures of geographical interaction.

Lastly, we apply the strategic balance approach developed by DEEPHOUSE (1999) in organisation science to the field of innovation and regional science. By introducing a dissimilarity measure for innovation strategy in a Deephousian way, a model is proposed which has the aim to show that simply allocating resources to innovation will not do the job. A smart, that is, a somewhat dissimilar, innovation strategy has to be added in order increase firm performance. In this way, we contribute to the development of the interdisciplinary field of regional science by using insights from organisation science (neo-institutional theory, resource-based theory of the firm, and resource dependency theory) in a complementary way.

In order to realise these goals, we address the following research question: To what extent do firm-specific resources, organizational embeddedness, proximity, and industry factors influence innovative and economic outcomes?

THEORETICAL FRAMEWORK

Many scholars stress the importance of industrial innovation for economic performance and development. The long-term growth of organisations and thus of regions and nations depends on their ability to continually develop and produce innovative products and services (STERNBERG, 2000). Moreover, this innovative activity takes place in a world that is characterised by increasing uncertainty resulting from fast-changing technologies and global competition. As a result, firms are on the one hand encouraged to concentrate on their core competences and value chains are disintegrated (STORPER, 1997). On the other hand, this increasing division of labour among organisations forces them to rely more heavily on inter-organisational exchanges, transfers and collaborations and to make a move from hierarchical governance structures to network governance structures that are based upon trust and reciprocity instead of threat and coercion (OLIVER, 1990). Especially the advocates of network approaches to innovation (SAXENIAN, 1990; DEBRESSON AND AMESE, 1991; MAILLAT, 1991; HÅKKANSSON, 1993; FISHER, 1999) stress the benefits of collaborating and interacting with external actors for the innovative capacity of firms. The view that no firm may function efficiently as an island on itself has become somewhat axiomatic (FREEL, 2003).

Elsewhere (OERLEMANS ET AL, 1998) we have stated that the (geographical) network approach to innovation tends to overemphasise an inter-organisational approach to organisational processes like innovation. As a result, there is a propensity to undervalue the contributions made by internal resources. Yet, in most industries the greater part of innovation effort is made by firms themselves and occurs within firms themselves (NELSON, 2000). We therefore have to find a balance between an internal and external view of innovation. A comparable approach was used by STERNBERG AND ARNDT (2001), who addressed in their paper the question whether the innovation activities of SMEs in ten European regions were influenced by firm-level or by region-level factors.

Economic actors will allocate resources to the exploration and exploitation of new products and processes if they know, or believe in, the existence of some sort of scientific, technical or market opportunity that could lead to economic benefits (DOSI, 1988). The innovation process of individual firms can be conceived as an open system (KATZ AND KAHN, 1966) where heterogeneous (knowledge) inputs are transformed into outputs (results of innovation). As far as this process is related to external economic actors, it is useful to distinguish two categories of external knowledge inputs: unintentional and intentional (TORRE AND GILLY, 2000; HUR AND WATANABE, 2001; BRESCHI AND LISSONI, 2001).

With regard to the first category, we refer to the spillover literature in economics (ACS ET AL., 1994; AUDRETSCH AND FELDMAN, 1996). Because of the non-rivalness property of knowledge, knowledge producing economic actors cannot fully appropriate the results of their activities and these results spill partially over to other actors on an involuntary and unintended basis (HARABI, 1997). As a result, positive externalities will occur and this knowledge will circulate in the economy, thereby creating increasing returns relating to scale and long-term growth (GRILICHES, 1992). Besides dealing with the question whether knowledge spillovers exist and are confined in geographical space, the empirical literature on the 'geography of innovation' (FELDMAN, 1999) tries to evaluate to what extent knowledge spillovers are better described as 'Marshallian' externalities (also known as MAR externalities), which refer to intra-industry economies of localisation, rather than 'urbanisation' externalities (also known as Jacobs externalities), which refer to inter-industry knowledge spillover and emphasise the importance of diversity. However, as will be explained below this does not imply that either of these types of external inputs can be acquired without any costs by an innovator firm. Moreover, recently BRESCHI AND LISSONI (2001) reviewed mainstream R&D spillover literature. Their main critiques can be summarised in three points. First, what R&D spillover literature presents as pure knowledge externalities are often in fact economic transaction externalities, which are mediated by economic mechanisms. Second, what R&D spillover literature puts forward as involuntary knowledge spillovers, are in fact well-organised knowledge flows between academics institutes and firms, or between firms, which are purposely governed and are therefore voluntary and negotiated flows of knowledge. Third, an important part of the knowledge flows mentioned above do not increase innovation opportunities of firms (by supplying them new ideas or knowledge), but enhance the innovation appropriation competences of (local) companies (by the provision of training and consultancy). An important lesson to be learnt from this critical assessment of R&D spillover literature is that scholars have to be aware of the existence of different types of knowledge flows and their impact on (local) firms. This paper tries to be sensitive to these different types of knowledge flows by distinguishing between (unintended) sectoral (SOETE AND TER WEEL, 1999) and regional (CANIËLS AND VERSPAGEN, 2001) spillovers (the first category) on the one hand. On the other hand, it discerns a second category encompassing intentional information and knowledge flows stemming from the organisational field, and market mediated knowledge flows originating from either intra- and/or inter-regional innovative ties with important buyers and suppliers.

After this discussion of balancing the internal and external view of innovation, the stage is set for the development of a theoretical model that will enable us to explore empirically the relative effects of firm-specific resources, network, regional and industry factors on the innovative and relative economic performance.

FIRM-SPECIFIC RESOURCES

The central proposition of the resource-based approach is that firms select actions that best build on and maintain their unique set of resources in order to stay competitive (COMBS AND KETCHEN, 1999). In the context of innovation, technical knowledge is the main strategic resource to be developed or acquired (HAGE AND ALTER, 1997). In-house R&D activities and highly educated personnel (firm's internal resource base) are often perceived as the most effective way to accomplish this. These internal resources are very important not only for developing one's own product and process innovations but also for monitoring competitors and absorbing the latest technological trends on the market (COHEN AND LEVINTHAL, 1990; HARABI, 1997). In line with the above argument, most scholars assume that there is a positive relation between the strength of firms' internal resource bases and outcomes, i.e. stronger internal resource bases are associated with higher outcome levels.

DEEPHOUSE (1999) proposed an alternative and more fine-grained theoretical argument: a theory of strategic balance in which relations between strategic similarity, competition, legitimacy, and performance are addressed. Deephouse's approach basically combines several theoretical approaches in organisation science. On the one hand, he uses insights derived from strategic management literature (BARNEY, 1991) arguing that differences between organisations impact positively upon competitive advantage, as well as from organisational ecology theory in which it is stated that dissimilar firms have lower levels of competitive intensity, which increases their survival rates (HANNAN et al., 1991). This line of thought is labelled the differentiation proposition. On the other hand, neo-institutional and resource dependency theory (DIMAGGIO AND POWELL, 1983) contend that higher levels of isomorphism have a positive influence on social and economic fitness of organisations. This point of view is addressed as the conformity proposition.

More in detail, the differentiation proposition holds that an organisation with a different strategy benefits because it encounters less competition on different markets for competition. Markets contain a limited number of resources, which are divided among organisations that have similar strategic positions. Therefore, a firm that conforms to the strategies of others has many similar competitors that limit the performance of the firm and increases failure rates because of higher levels of competition over scarce resources (BAUM AND SINGH, 1994). The conformity proposition reasons that a firm that is similar to other firms avoids legitimacy challenges that hinder resource acquisition. As a result of iterative isomorphic processes, the organisational field institutionalises and legitimates a range of strategies, which are perceived as normal. Firms select strategies to gain future success, and successful strategies are imitated, which is understandable because strategy selection is an inherently uncertain process. During this process, a range of normal strategies becomes legitimated, that is to say, these are acceptable to the organizational field. A firm that selects strategies outside of the range of accepted strategies is confronted with legitimacy challenges. In this context, legitimacy can be defined as "a generalized perception that the actions, activities and structures of an organization or a network are 'desirable and appropriate' especially to key stakeholders' (PROVAN ET AL., 2004).

By combining the differentiation and conformity proposition, DEEPHOUSE (1999: 154) arrives at a middle ground of strategic balance and argues that the organisation will achieve maximum performance at the level of strategic similarity where the gains from reduced competition are equal to the costs of legitimacy challenges. At greater levels of dissimilarity the costs of legitimacy challenges are greater than the benefits of lower competitive intensity, which is associated with lower performance levels.

Deephouse shows empirically that both reduced competition and legitimacy improve firm performance. Therefore, his conclusion is that firms have to balance the pressures of competition and legitimacy. This implies that a certain amount of similarity between firms in a sector as to their strategic orientation is most conducive to performance, while dissimilarity inhibits performance.

In the context of innovation, innovation strategy similarity could be used as an application of Deephouse's approach. Firms that have innovation strategies very dissimilar to other firms in a sector are subject to questions and actions challenging their legitimacy and rationality. Why is this the case? To answer this question, one has to look at the functions of legitimacy for organisations. Two important dimensions with regard to this are (SUCHMAN, 1995): (a) continuity and credibility and (b) the type of support. Legitimacy leads to continuity because stakeholders are most likely to supply resources to organisations that appear desirable, proper, or appropriate. Moreover, legitimacy also affects how stakeholders understand an organisation. In other words, stakeholders perceive the legitimate organisation not only as more worthy, but also as more trustworthy. If an organisation lacks this credibility, it is more vulnerable to claims that it is negligent, irrational or unnecessary.

The second dimensions focuses on whether the organisation seeks passive or active support of relevant stakeholders. As far as passive support is concerned, demands on legitimacy are low. However, if an organisation wants active support from stakeholders, legitimacy demands may be more stringent because it has to have value for the stakeholders whose support is needed (SUCHMAN, 1995: 575).

Therefore, in the case an innovating firm has a very dissimilar innovation strategy, this could affect its ability to acquire (knowledge) resources from exchange partners in the organisational field (DIMAGGIO AND POWELL, 1983). Moreover, this could impact on its trustworthiness, and thus affect the willingness of other actors to cooperate with this particular organisation. These effects could have serious consequences for the innovation process.

At the same time, firms feel the need to be different since differentiation is a basis for a strong competitive position. Some firms could opt for innovation strategies in which the emphasis is on improving service instead of on newness, while others try to distinguish themselves by knowledge intensive strategies. In both cases, firms try to establish niche positions that could improve their relative performance and reduce competition. As long as the benefits of differentiation outweigh the costs of legitimacy challenges, the performance of the firm will increase. At greater levels of dissimilarity, the costs of legitimacy challenges exceed the gains of differentiation, leading to lower performance levels. The general implication is that a firm has the highest performance at moderate levels of similarity. In other words, we expect an inverted U-shape relationship between the level of innovation strategy similarity and outcomes. Therefore, our first hypothesis reads:

Hypothesis 1: There is a curvilinear, concave down relationship between levels of innovation strategy similarity and relative outcomes.

The organisation of internal R&D activities is a second firm-specific resource, which has to be taken into account. As an analogy to COHEN AND LEVINTHAL's two faces of R&D argument (1989), we propose the idea of the two faces of the organisation of R&D. On the one hand, the organisation of in-house R&D activities in a department indicates that the undertaking of these activities is a more well-organised, routinised and continuous process and that the firm is used to change, which is an inevitable by-product of innovative activities (MEEUS AND OERLEMANS, 2000). The presence of an R&D department is on the other hand especially of importance in research related collaborations. It gives external partners an identifiable and recognisable unit within an organisation, which facilitates the transfer of knowledge and information. This eases the production of innovations and related economic results. Therefore we propose that firm that have organised their R&D activities have higher performance levels.

A large part of the internal knowledge base of an organisation is embodied in its employees and their Research and Development activities. In this sense the knowledge and skills of employees are a valuable asset in innovation processes. Firms with higher levels of higher educated employees or higher levels of R&D activities are assumed to have a larger variety of knowledge skills and experiences, which can be utilised in innovation. This yields the proposition that firms with larger human knowledge bases or higher R&D levels have higher performance levels.

The arguments discussed above enable us to formulate our second hypothesis:

H2: There is a positive relationship between the innovator firm's internal knowledge resources (organisation of R&D, R&D effort, and human resources) and its relative performance.

ORGANISATIONAL PROXIMITY

TORRE AND GILLY (2000) argue that for the explanation of the nature of the effects of proximity and the endogenisation of the space variable in economic theory, at least two dimensions have to be distinguished, namely organisational proximity (discussed in this section) and geographical proximity (see the next section). In their approach, the former is based on an adherence and similarity logic. The adherence logic refers to actors that are close in organisational terms belonging to the same space of relations (networks), that is, actors are in interactions of various natures. Their view resembles Granovetter's idea of embeddedness, i.e., the extent in which economic action and outcomes of firms is affected by dyadic relations and by the structure of the overall network of relations (GRANOVETTER, 1985). Embeddedness performs several functions in the context of innovation (HÅKANSSON, 1989). Firstly, it has a function for the knowledge development process in an economy. Ideas and knowledge needed to develop innovations is often a product of the confrontation of different fields of knowledge. Especially the interactions between heterogeneous actors and resources in a space of relations provide a platform for this confrontation. Secondly, embeddeness has a coordination function. The success of product and process innovations is highly dependent on the extent to which they are adapted to already existing technical systems and/or focussed on market demands. Inter-firm interaction enables actors to communicate with and monitor external parties in order to perform feasibility checks on chances and threats of technological opportunities and changing user needs (LUNDVALL, 1992). The mobilisation of external resources is a third function. Firms rarely have all required resources internally to innovate successfully. As a result, some of these resources have to be acquired externally. Because resources are heterogeneous, i.e., their economic value depends on other resources with which they are combined; innovating firms have to be knowledgeable about their uses and performances. Learning is a way to accomplish this. As far as external resources are concerned, this type of learning is called learning by interacting: firms make actively use of the knowledge and experience of a variety of economic actors in their network (HAKANSSON, 1993). Therefore, hypothesis 3 reads:

H3: There is a positive relationship between the extent to which innovating firms utilise their external resources bases and their relative performance.

SPATIAL PROXIMITY

In terms of the role of spatial proximity in facilitating innovation networks two bodies of literature can be discerned: regional R&D spillover literature (ACS ET AL., 1994; AUDRETSCH AND FELDMAN, 1996; FELDMAN AND AUDRETSCH, 1999) and spatial interaction literature (BECATTINI, 1989; SAXENIAN, 1994; MASKELL AND MALMBERG, 1999). The main difference between the two lies in the theoretical mechanisms explaining the relation between innovation and proximity.

As already discussed by THOMPSON (1962), regional R&D spillover literature argues that innovation is a cumulative activity, implying that firms located in regions that have accumulated high levels of innovative success and possess a relevant stock of knowledge will be favoured in the next rounds of innovation. Two interrelated mechanisms are put forward as explanations. Due to the partially non-rival nature of the locally accumulated knowledge on the one hand, and an assumed distance decay function of knowledge transfer on the other, this knowledge spills unintentionally and in particular over to firms located in the region. Moreover, these effects are sustainable over time. Firms located in regions that first emerged as centres of innovative activity tend to sustain this advantage over time. Basically, this is a variation on Myrdal's theory of cumulative causation.

Just as in the regional spillover literature, spatial interaction literature assumes a negative elasticity with regard to the transfer of (technological) knowledge in space. The level of codification is important here since spatial proximity is assumed to be of importance especially in case tacit knowledge has to be exchanged. Moreover, in contrast to regional spillover literature it is intended interaction between economic actors that is functioning as the mechanism of knowledge transfer. Although the spatial interaction literature has a heterogeneous nature because of its great variety of concepts and perspectives, the importance of inter-personal links, of a common institutional culture amongst workers, entrepreneurs and politicians, and of a positive attitude towards collaboration, all facilitated by spatial proximity, stimulate interactions between actors in general and the flow of knowledge and information in geographical space in particular. These notions can be found in industrial district theory (ASHEIM, 1996), the innovative milieux approach (AYDALOT AND KEEBLE, 1988), and the 'New Industrial Spaces' approach (STORPER, 1997). They all assume that firms that tap into tacit regional knowledge flows will acquire necessary resources more easily, and are therefore able to perform better.

Recently, however, several scholars have challenged the belief that the relative simple dichotomy between codified and tacit knowledge is crucial for our understanding for the role of geographical proximity. For example, ASHEIM (1999: 348) argues that 'localised learning is not only based on tacit knowledge, as we argue that contextual knowledge also is constituted by "sticky", codified knowledge'. This latter type of so-called disembodied knowledge is, according to him, based on individual skills and experience, a collective technical culture and a well-developed institutional framework, which are all highly spatially immobile.

TORRE AND GILLY (2000) state that there is a frequent combination of tacit and codified within firms and networks. LUNDVALL (1996) maintains that the growth of knowledge-based networks and teams may be seen as an expression of the increasing importance of knowledge, which is codified in local rather than universal codes. Next, he argues that the skills necessary to understand and use these codes will often be developed by those actors allowed to join the network and be a part of interactive learning processes. In other words, Lundvall adds to the discussion a social network perspective in which processes of inclusion and exclusion are important.

BRESCHI AND LISSONI (2001) develop this argument further by pointing at the existence of epistemic communities in which specific language for the exchange of technical and scientific messages is used. A lack of disclosure of these codes may function as a strong device of exclusion, even for actors in the same region. Furthermore, they argue that since tacitness and codification are mutually compatible, tacit knowledge can be communicated over even long geographical distances by means of different media. The implication is that innovating firms have to tap into networks at different geographical levels in which both tacit and codified information and knowledge are transferred. ASHEIM (1999: 349), LUNDVALL AND BORRAS (1999: 33), DICKEN AND MALMBERG (2001: 356), and STERNBERG AND ARNDT (2001) developed comparable lines of thought. The latter authors (2001: 372) state, “it is necessary to establish network relationships at both the intra-regional and inter-regional level”, since regional know-how and synergy alone are not sufficient to considerable dynamic market and technological changes.

On the basis of the considerations discussed above two hypotheses can be formulated:

H4a: There is a positive relationship between the utilisation of regional R&D spillovers by innovating firms and their relative performance.

H4b: Innovation firms with both intra-regional and inter-regional innovative ties with buyers and suppliers have a higher relative performance.

INDUSTRY FACTORS

In his seminal paper, PAVITT (1984) showed that there are important sectoral differences with regard to innovative activity. As was stated in a previous section, firms cannot prevent that the results of their knowledge production efforts partially spills over to other firms in the same sector. Therefore, we take a Marshallian approach to R&D spillovers. Several scholars take the same position. For example, HENDERSON (1999) finds evidence that specialisation matters more than diversity, whereas MASKELL (2001) argues that cognitive distance makes inter-firm cooperation across bodies of knowledge more costly (see also NOOTEBOOM, 1999). BRESCHI AND LISSONI (2001) maintain that it is improbable that tacit knowledge, which needs mutual understanding of working practices, can be exchanged across industries by means of informal contacts (see also KEELY, 2003). Recently, JACOBS ET AL. (2002) stressed the importance of intra-sectoral R&D spillovers for the Dutch economy. They found that the elasticity of total factor productivity with respect to R&D was about 40% for intra-sectoral R&D, and about 15% for R&D by other Dutch sectors. This results in our fifth hypothesis:

H5: There is a positive relationship between the extent to which innovating firms are able to appropriate sectoral knowledge flows and their relative performance.

INNOVATION OUTPUT AND ECONOMIC PERFORMANCE

As was stated before, economic actors will allocate resources to the exploration and exploitation of new products and processes if they know or believe in the existence of opportunities that could lead to economic benefits. The research presented in this paper enables us to find out whether the results of explorative and exploitative efforts (innovation outcomes) do lead to economic benefits. It is generally assumed that innovation is conducive to economic performance. Innovation is creating something different or new which could lead to (temporary) niche positions on the market. Such positions enable innovators to profit from monopolistic rents. Therefore, our sixth hypothesis reads:

H6: There is a positive relationship between relative innovation outcomes and relative economic performance.

RESEARCH DESIGN

DATA SOURCE

This article draws on a survey on R&D, networks and innovation in the Netherlands. The survey was held in 1995 (relating to firm behaviour in a 5-year period) among some 5,500 selected manufacturing and services firms with more than five employees[2]. A random stratified sample[3] was taken from the database of the Dutch Chamber of Commerce, which is the largest administrative database with firm level data (e.g. addresses, size) publicly available in the Netherlands. A postal survey was send to the selected firms. The questionnaire covered a wide range of topics, ranging from general firm information (e.g. age, sales, main economic activity, location) to innovative behaviour (e.g. R&D effort, type of innovations and their features, innovation problems), and features of inter-organisational relationships (e.g. duration, location, contact frequency of ties). The response rate was 8%, i.e. 365 firms. A comparison with relative sector employment data derived from the on-line StatLine database

[2] Selected sectors were: Food industry; textiles, clothing & leather industry; paper & printing industry; basic metal industry; machine building industry; construction material industry; chemical & plastics industry; electronics industry; transport equipment industry; construction industry; business & IT services.
[3] Sector was taken as the stratum variable.

of the Dutch Bureau of Statistics revealed that our response sample has considerable bias. Combined with the relatively low response rate, it can be concluded that our findings are not representative for the Dutch business community. Nevertheless, the number of cases is quite sufficient to perform a number of multivariate exploratory analyses and come to meaningful analyses.

Firms were classified in four regions: The region West (34% of the firms in our sample) containing the provinces Utrecht, North and South Holland, Flevoland; North (13% of firms in sample) comprising the provinces Groningen, Friesland and Drenthe; East (20% of firms in sample) are the provinces Gelderland and Overijssel; and South (33% of firms in sample) encompassing the provinces Zeeland, North Brabant and Limburg. Firms were grouped in four regions for two reasons. Firstly, from a methodological point of view categories (such as regions) should contain a minimum number of cases in order to conduct meaningful statistical analyses. Using a lower spatial level would have implied that this assumption would have been violated. Secondly, some notable structural economic differences can be noted between these four regions (see also footnote 10). On theoretical grounds, it can be expected that firms located in regions that differ with regard to sectoral composition and job density will experience different level of interaction possibilities, probably impacting on their performance.

MEASUREMENT OF VARIABLES

In this paper, the relative effects of firms' internal resources, network, regional, and industry factors on firm's relative performance are explored. However, firm performance is a multi dimensional concept and can therefore be measured in multiple ways. In a previous section, we defined the proximity effect as the comparative advantages of regional ties in comparison to non-regional links. As a result of the focus of this paper, these comparative advantages lie on two related fields: innovative and economic. If the different forms of proximity indeed have the assumed effects, it eases the innovation process and will contribute to more positive innovative outcomes for innovator firms. From an (regional) economic perspective however, higher innovative outcomes do not necessarily translate into some form of regional economic development because not every innovated product or service has long lasting success in the market. It is therefore of interest to find out whether the proximity effect also holds for indicators related to economic performance.

Two indicators will be used for the measurement of relative innovative performance. The first is the *relative percentage of new processes and products* in the time period 1989-1994. This variable describes the difference between a firms' percentage of new processes and products and the average percentage of new products and processes of all innovating firms in the sector of which the firm is a member. Firms were asked to indicate which percentage of the processes and products were new to the firm in a 5-year period. Higher positive (negative) scores on this variable indicate relatively higher (lower) levels of newness compared to the sector mean. The second indicator of innovative outcomes is the *relative scope of innovation results*. Results of innovation are not only physical in nature. Part of the innovative efforts of firms are directed at, for example, a reduction of cost prices, quality improvements, or the speeding up of internal processes. In other words, this variable captures the more qualitative dimensions of innovation outcomes. Moreover, if firms are able to realise a wider variety of results as outputs of their innovation processes, this is evaluated as a higher level of performance. To measure the relative scope of innovation results, we asked firms to indicate to what extent process and/or product innovations resulted in (a) reductions of cost prices; (b) quality improvements of processes and/or products; (c) increases of production capacity; (d) improvements in delivery time; (e) increases in sale, and (f) increases in profits[4]. A compound variable was calculated as the average sum score of the items mentioned above. Next, relative levels were calculated in the same way as with the previous performance indicator.

The second group of indicators describes relative economic outcomes. After all, at some point in time the produced innovations should create economic value for the firm and in a wider context for a regional or a national economy. We discern two types of economic outcomes: the relative average annual growth percentage of sales in 1989-1994, and the relative average growth percentage of employment in the same time period[5]. The relative levels of both variables are calculated in the same way as the first performance indicator.

In line with our theoretical model, four groups of independent variables are distinguished. *Firm specific resources* are described using three variables. The way the measure of innovation strategy similarity is calculated is based on DEEPHOUSE (1999). Innovation strategy was measured by asking innovating firms the question for what reasons they innovated looking back on a 5-year period. Firms could select from a list of 16 items and indicate the extent to which a specific item applied to their situation[6]. Next, these 16 items were entered into a factor analysis in order to find out whether or not a latent structure could be discovered in the data. The results of this analysis are presented in Table 1, in which can been seen that six factors can be distinguished ranging from an innovation strategy aiming at improving market position to a more reactive strategy in which firms innovated because of buyer needs.

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[4] Answers: (1) Very little; (2) little; (3) not little/not much; (4) much; (5) very much.
[5] Both variables are calculated as: [[[[sales (employment) 1994 – sales (employment) 1989] / sales (employment) 1989] * 100] / 5] – sector mean sales (employment) 1994.
[6] Items included were: Increasing production speed, cost price reduction, improving delivery speed, improving quality, increasing market share, maintaining market share, discovery of new market need, solving technical product problems, solving production process problems, new technical idea, competitor had innovated product, competitor had innovated process, technical standardisation (DIN/ISO), reaction to new regulations and laws, buyer asked for new process method, buyer asked for new product. A 5-point Likert scale was used: (1) very little; (2) little; (3) not little/not much; (4) much; (5) very much.

Insert Table 1: Results of factor analysis on innovation strategy items

Following DEEPHOUSE (1999), standard deviation units were used because these indicate the level of conformity. The following equation illustrates the calculation of innovation strategy deviation of a firm in sector j, where IS_{ij} is the innovation strategy of firm i in sector j, *ABS* is the absolute value function, $M(IS_j)$ is the sector mean of of an innovation strategy, and $SD(IS_j)$ is its standard deviation in sector j.

$$Innovation\ Strategy\ Deviation = \sum_{i,j}^{n,o} ABS\left[\left(IS_{i,j} - M\left(IS_j\right)\right) / SD\left(IS_j\right)\right]$$

This calculation was done for all innovation strategies and the absolute values of the standard deviations were totalled for each firm. Therefore, this variable indicates to what extent a firm's innovation strategies deviate from what is 'normal' in its sector. The range of innovation strategy deviation included all numbers greater than or equal to zero. The variable equals zero if and only if firms have the same innovation strategy, whereas higher values signal higher levels of deviation.

Second, R&D department, which is a dummy coded variable. The value 1 is assigned in case an innovating firm has such as department and 0 in all other cases. The third variable used is the strength of the knowledge resource base of the innovation firm. This is a compounded construct in which two variables are used: R&D effort measured as the percentage of the workforce of a firm devoted to research and development activities, and the percentage of higher educated employees in a firm[7]. Since the production of innovations is largely dependent on the capabilities of a firm to generate, absorb, and transform knowledge, both R&D effort and highly educated personnel embody these capabilities.

[7] To avoid collinearity problems, the average sum score of the two variables was calculated. The Pearson correlation of the two variables is 0.395 ($p < 0.000$) indicating that this problem would occur when both variables should have been entered separately in an analysis.

Network activity, or organisational proximity in the words of TORRE AND GILLY (2000), of innovating firms is measured with two types of variables, R&D cooperation on the one hand and external contributions to the innovation process on the other. The main difference between the two is related to the distinction between availability and utilisation. The variable R&D cooperation is a count of the number of research collaborations of the innovating firm with a variety of external actors[8]. In many studies (e.g. BROUWER AND KLEINKNECHT, 1996), R&D cooperation is viewed as direct input for the innovation process. We take a different position. Having collaborative arrangements with external parties does not necessarily imply that actual transfer of knowledge is realised. In our view, these collaborations are a necessary precondition that enable firms to interact and indicate whether appropriate channels for communication are available. The actual interaction and utilisation is measured with a second variable 'external contributions to the innovation process'. In our survey, we asked innovating firms how often in the last five years external organisations thought up ideas for, or made important contributions to, the realisation of innovations[9]. These 12 items were entered in a factor analysis.

Table 2: Results of factor analysis on external contributions to the innovation process

This analysis resulted in a solution with four factors: external contribution to innovations by (1) intermediaries (Trade organisations, Chambers of Commerce); (2) educational institutes (universities and polytechnics, both technical and general); (3) business agents (buyers, suppliers, and competitors); (4) innovation advisers (Innovation Centres,

[8] External actors involved are: suppliers, buyers; competitors; educational institutions, R&D labs, and engineering companies.

[9] External organisations included were: Trade associations; National Centres for Applied Research (TNO); private consultants; buyers, suppliers; competitors; chambers of commerce; regional innovation centres; technical universities; other universities; colleges for professional and vocational education. A 5-point Likert scale was used to measure the frequency of interaction: (1) never; (2) sometimes; (3) regularly; (4) often; (5) always.

consultants). Items that loaded high on a factor were entered in a reliability test using the Cronbach's Alpha model of internal consistency. Alpha's ranged from 0.46 to 0.73, which are acceptable to good levels. Firms that have more R&D relationships and are able to interact more intensively with external organisations have more access to and utilise external knowledge bases more intensively, which enables them to achieve higher performance levels.

The variables that will be used to measure the influence of *geographical proximity* on performance belong to one of two groups. The first group (one variable) measures regional R&D spillovers. The Netherlands is split into 4 regions[10] and for every region the average regional R&D effort is calculated as a proxy for regional R&D spillovers. BEUGELSDIJK AND CORNET (2002) followed a comparable approach. Depending on its location, this regional R&D effort is assigned to a specific firm. Higher values of this variable indicate higher levels of regional R&D spillovers. The second group of proximity variables contains three variables. Firms were asked to indicate the geographical location of the buyer or supplier most important to their innovation processes. First, these variables are dummy coded, with a value 1 in case this buyer or supplier is located in the same region and 0 in all other cases. Second, following STERNBERG AND ARNDT (2001), variables were constructed that indicated whether or not a firm's most innovative ties with buyers and suppliers were (1) intra-regional only; (2) inter-regional only; (3) both intra- and interregional, and (4) no significant innovative ties (control group).

The last independent variable in our model is an indicator for sectoral R&D spillovers. Firms were grouped in six sectors: traditional industry, metal industry, IT sector, business sector, chemicals and plastics, and construction (materials). For each of the six sectors, the

[10] Although the Dutch economy can be characterised as a service economy (about 75% of all jobs can be found in commercial and non-commercial services), notable structural economic differences between the regions exist. First, the highest concentration of jobs can be found in the West region (0.39 per capita, 50% of all jobs in the country), while the lowest level is to be found in the North region (0.32 per capita, 9.3% of all jobs). Second, the sectoral composition of employment shows some meaningful differences. The South region is the most industrialised (24.2% of all jobs in manufacturing, East 19.7%; North 18.5%, West 12.3%). The West region specialises in commercial services (almost 49% of all jobs, 31% of the jobs in the non-commercial sector). As a result about 80% of all employment in the West region are service jobs (North 72%; East 71%; South 67%.

average sector R&D effort was calculated. This figure was assigned to an innovating firm according to its sectoral code. Higher values of this variable indicate higher levels of sectoral R&D spillovers. Therefore, sectoral R&D is taken as a stock of R&D spillovers (JACOBS ET AL., 2002) of which it is assumed that it can flow to other firms in the same sector.

To control for size effects, a dummy-coded variable was included. The dummy takes the value of 1 if a firm has 50 or more employees, and 0 in all other cases. It assumed that because of economies of scale, large firms are able to generate relatively higher outcomes as compared to their smaller colleagues in their sector.

MODEL ESTIMATION ISSUES

In order to test the relative importance of firm-specific resources, network, proximity, and sectoral factors on different dimensions of firm performance, four models (one for every performance indicator) were estimated using stepwise OLS regression analysis with pairwise deletion. The models were estimated without an intercept. The argument for this decision is rather straightforward. Including an intercept in the models would imply that firms could have a certain level of (innovative) outcomes independent from the fact whether they perform innovation related activities. In the context of this paper, that would be improbable.

An econometric concern in estimating the models is the existence of multicollinearity among the independent variables. To check for multicollinearity, we used the so-called variance inflation factor (VIF), which is the reciprocal of the tolerance. As the VIF increases, so does the variance of the regression coefficient, making it an unstable estimate. Large VIF values are an indicator of multicollinearity (TACQ, 1997). The variance inflation factors found in our estimates ranged from 1.14 to 1.53, expressing the fact that no multicollinearitiy problems occurred.

EMPIRICAL RESULTS

Table 3 shows the results of the stepwise OLS regression for the four different outcome variables we distinguished. In the first hypothesis, it was argued that there would be a curvilinear, concave down relationship between levels of innovation strategy similarity and relative outcomes. This relationship is found for the models in which relative average annual growth percentage of employment (model 3), and average annual growth percentage of sales (model 4) were the dependent variables since the squared term of innovation strategy similarity is negative and statistically significant indicating an inverted U-shape association. This result indicates that the more innovation strategies of firms in a sector deviate from sectoral means, the lower the relative economic outcomes of these firms are. Therefore, for the indicators of relative economic outcomes Deephouse's strategic balance theory was empirically confirmed.

However, a different result emerges when relative innovation outcomes are taken into account. In both models (1 and 2), it is found that higher levels of innovation dissimilarity are associated with higher levels of relative innovation outcomes. These findings reflect Deephouse's differentiation proposition, that is, the more a firm's innovation strategies differ from their sectoral colleagues, the higher the relative innovation outcomes are. It seems that being different pays out when it comes to innovation.

Insert Table 3: Results of OLS stepwise regressions here

It turns out that having an R&D department, which was used as an indicator of the two faces of R&D organisation, is only beneficial for innovating firms when it comes to generating new or improved products and processes. In hypothesis 2 it was also assumed that firms with stronger internal resource bases would outperform their firms in the same sector. This hypothesis is only confirmed in the model in which relative sales growth is the dependent variable. It should be noted, however, that these findings do not indicate that R&D departments or R&D intensity are unimportant. They only show that having an R&D department or having a stronger internal resource base is not sufficient to outperform other firms in the same sector.

In sum, the overall results with regard to the associations between innovation strategy similarity and internal resources on the one hand, and performance levels on the other show that there is mixed evidence in support of hypotheses 1 and 2.

In hypothesis 3, we argued that higher levels of network activity were positively associated with the performance of innovating firms. Regardless of the relative output indicator used, contributions to the innovation process of the focal innovating firm by business agents (important users and suppliers) are positively associated with relative outcomes. Besides this overall result, varying patterns for the different dimensions of performance were found. The estimate with relative growth of employment as the dependent variable shows that in addition to the contributions to the innovation process of the focal firm by business agents, contributions made by educational institutes increase relative growth of employment. The estimate in which relative growth of sales serves as a dependent variable shows that utilising a broader range of inter-organisational relationships is beneficial to firms. In this model, the utilisation of the contributions of business agents, as well as of educational institutes and intermediaries is positively associated with relatively higher levels of growth of sales. In general, these findings lead to the conclusion that higher levels of inter-organisational activity, that is utilising the resources of a broader set of external actors more intensively, are associated with higher relative growth levels of employment and sales, but interestingly enough this is not applicable to the models in which innovation outcomes are the dependent variables, in which only contributions of business agents are of importance for relative performance.

The geographical proximity effect turns out to have a limited and specific impact on relative outcomes. In all four models, an indicator of geographical proximity proves to be statistically significant with the expected sign. However, findings vary depending on the relative outcome variable used. Firms with relatively high levels of changed processes and products (model 1) seem to benefit from intra-regional innovative ties only as well as from intra- and inter-regional ties. STERNBERG AND ARNDT (2001: 370) using data from the European Regional Innovation Survey (ERIS) reported a comparable finding. In model 4, in which relative average annual growth of sales is the dependent variable, the combination of intra- and interregional innovative ties with important buyers and suppliers, improves economic performance. Lastly, for two models (relative scope of innovation outcomes, and relative average employment growth) highly statistically significant, positive associations can be reported between regional R&D spillovers and relative performance. Basically this result signals that firms benefit from being located in the more agglomerated Dutch regions (West and South). BROUWER ET AL. (1999) found similar patterns using the number of new products announcements as a dependent variable. Overall it can be concluded that hypotheses 4a and 4b are only partially confirmed.

The effects of sectoral R&D spillovers prove to be significant and have the expected sign. With the exception of the model in which relative average growth of employment is the dependent variable, it can be concluded that higher sectoral R&D spillovers are associated with higher relative performance levels, confirming hypothesis 5. This result is often found in empirical studies on this type of R&D spillovers (see for example: CANIËLS AND VERSPAGEN, 2001; LOVE AND ROPER, 2001).

Hypothesis 6 is confirmed in both estimates (model 3 and 4). Firms with relatively high levels of changed processes and products tend to have higher levels of growth of employment as well as of sales in comparison to the average of other firms in the same sector.

In all models, a dummy variable was included to control for size effects. Only in the model with relative scope of innovation outcomes, a high statistically significant size effect could be noted, highlighting that larger firms are able to produce a wider variety of more qualitative innovation outcomes as compared to small firms in the same sector.

DISCUSSION AND CONCLUSION

The main aim of this paper was an empirical exploration of the importance of firm-specific resources, organisational and geographical proximity, and sectoral factors for relative firm performance. The paper used a theoretical synthesis of organisational science (resource based theory, network theory, neo-institutional theory) and regional science (district theory, systems of innovation) accounting for relative innovative and economic outcomes. The resulting research model enabled us to derive several hypotheses on the influence of proximity on outcomes, taking other important predictors for performance of firms also into account.

The confrontation of our hypotheses with our findings gives rise to some interesting discussions. Deephouse found that intermediate levels of strategic similarity were conducive to economic performance of firms. A comparable result was found in our study in which innovation strategy similarity was used as one of the independent variables and economic performance of firms as dependent variables. Therefore, in case of relative economic performance balanced innovation strategies seem to pay out. However, in case innovation outcomes were the independent variables, it was found that dissimilarity increased relative innovation outcomes. First, these findings show that the strategic balance approach, as applied here to innovation, is sensitive for different types of outcome variables. Second, one could interpret these results as a different perspective on the need of balancing strategies depending on the type of activities a firm is conducting. The very nature of innovation is to come up with different, changed products and services. By implementing an innovation version of a differentiation strategy, firms are able to achieve this. However, innovated product and services have to be successful in the market too, which means that the success of the innovating firms becomes dependent on third parties (buyers) that legitimatise firms' actions. Therefore, it seems that innovating firms have to balance two types of different activities in order to be successful, which is a variation on the exploration versus exploitation discussion in innovation science.

The results for the network activity variables give also rise to some discussion. On the one hand, we found a general effect of the contributions of business agents (mostly important buyers and suppliers) to the innovation process. The production and product related technological knowledge embodied in these actors turned out to be of the most value for the relative innovative and economic performance of firms in our survey. On the other hand, only in the models with relative economic performance as dependent variables a broader variety of external contributions seem to matter, although we expected this would also be the case for innovative outcomes. An interpretation of these results is consistent with findings by BAUM AND OLIVER (1992). Their results suggest that embeddedness in the organisational environment underlies amongst others, the improved survival capabilities of a population of organisations. As far as relative growth of employment and sales can be regarded as an indicators related to a higher likelihood of firm survival, our findings point in the same direction.

Does geographical proximity matter for firms' performance? We found that it does, but in a limited and specific way: firms with both intra-regional and intra-regional innovative ties with buyers and suppliers tend to outperform other firms in the same sector as far as the percentage of innovated processes/products and relative growth of sales are concerned. STERNBERG AND ARNDT (2001) reported comparable findings in their study of innovation behaviour of European firms. On the one hand, this result confirms the theoretical idea that firms, which depend on regional knowledge bases only, do not receive sufficient knowledge and information inputs to outperform other firms in their sector. On the other hand, this result may be viewed as support for those scholars, who challenge the received wisdom of the importance of proximity for the transfer of tacit knowledge. Nevertheless, intra-regional innovative ties are of importance, which is also reflected by our finding that firms with inter-regional ties only do not perform better.

Although the indicator of regional R&D spillovers is statistically significant with the expected sign, this result could only be reported for two of the four models. Part of this mixed result is in line with the findings of BEUGELSDIJK AND CORNET (2002), who show that proximity (measured as regional R&D expenditures) does not impact on the development of new products (see results of model 1). Moreover, in the models in which the indicator of regional R&D spillovers is not statistically significant, the indicators of intra-regional and inter-regional innovative ties are. As far as spatial variables are concerned, it seems that indicators of actual interaction do better than indicators that assume interaction. This conclusion confirms JAFFE's (1989) observation that spillover literature does not model spillover mechanisms.

Our study shows that including both indicators for actual interaction and (sectoral) knowledge spillovers has explanatory value for firm performance. As indicators of intended and unintended knowledge flows in an economy, they point to the fact that researchers should take a balanced approach when dealing with these matters.

Do firms benefit from innovation? Our findings show that they do. Firms innovating their products and processes at above average sector level, have higher relative levels of growth of sales and employment. These results show that stimulating innovation is conducive to firm and regional economic growth. However, our estimates also show that findings differ considerably depending on the outcome variable used. This leads to the conclusion that researchers should be aware of the fact that firm performance is a multi-dimensional concept.

Finally, we are conscience of the fact that our analyses could be extended with tests of simultaneity and interaction effects. We excluded these, because the paper would get to crowded. Moreover, in assessing the contribution of our study some caution is needed. Our sample is relatively small and has sample bias. This puts some stress on the generalisation of our claims. Also caution should be exercised, because other regional economic variables, like e.g. sectoral differences or regional growth levels, were not included here.

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Table 1: Results of factor analysis on innovation strategy items

Factors and items: "We innovated because:"	Factor coefficients	Labels and Cronbach's alpha
Factor 1 (IS1):		
Increasing production speed	0.835	
Cost price reduction	0.784	Improvement of production process
Improving delivery speed	0.724	(Cronbach's alpha = 0.80)
Improving product quality	0.535	
Factor 2 (IS2):		
Increasing market share	0.844	Improvement market position
Maintaining market share	0.801	(Cronbach's alpha = 0.77)
Discovered new market need	0.656	
Factor 3 (IS3):		
Solving technical product problems	0.779	Solving technical problems
Solving production process problems	0.712	(Cronbach's alpha = 0.79)
New technical idea	0.700	
Factor 4 (IS4):		
Competitor had innovated product	0.876	Reacting to competitors
Competitor had innovated process	0.791	(Cronbach's alpha = 0.71)
Factor 5 (IS5):		
Technical standardisation (DIN/ISO)	0.854	Reacting to rules & regulations
Reaction to new regulation	0.731	(Cronbach's alpha = 0.56)
Factor 6 (IS6):		
Buyer asked for new process method	0.906	Reacting to buyers needs
Buyer asked for new product	0.570	(Cronbach's alpha = 0.48)

Table 2: Results of factor analysis on external contributions to the innovation process

Factors and items	Factor Coefficients	Labels
Factor 1 (F1)		
Chambers of Commerce Trade organisations	0.792	Contributions of intermediaries (Cronbach's Alpha = 0.61)
Factor 2 (F2)		
General universities	0.692	Contributions of educational institutes
Technical universities	0.672	(Cronbach's Alpha = 0.64)
Colleges	0.631	
Institutes for vocational training	0.628	
Factor 3 (F3)		
Important buyers	0.788	Contributions of business agents
Important suppliers	0.642	(Cronbach's Alpha = 0.73)
Competitors	0.618	
Factor 4 (F4)		
National Centre for Applied Research	0.804	Contributions of the innovation advisers
Innovation Centres	0.528	(Cronbach's Alpha = 0.46)
Consultants	0.353	
KMO = 0.657 Bartlett's Test of Sphericity = 370.788 Significance = 0.000 Cumulative % of variance explained = 55.175		

Table 3: Results of OLS stepwise regressions

Independent Variables	Relative outcomes: dependent variables			
	Relative percentage changed processes and products, 1989 - 1994	Relative scope of innovation outcomes	Relative average annual growth % of employment, 1989 - 1994	Relative average annual growth % of sales, 1989 - 1984
Innovation strategy similarity	0.341***	0.272*	2.403***	0.121
Innovation strategy similarity squared	0.000	-0.324	-1.937***	-0.203**
R&D department	0.140*	-0.011	0.034	0.006
Strength of the resource base	0.052	-0.094	-0.002	0.409***
R&D cooperation	0.039	0.078	-0.017	0.209**
F1: Contributions of intermediaries	0.028	0.006	-0.007	0.129**
F2: Contributions of educational institutes	0.038	0.032	0.205***	0.061
F3: Contributions of business agents	0.149**	0.141***	0.135**	0.103*
F4: Contributions of innovation advisers	0.084	0.026	-0.067	0.054
Intra-regional innovative ties	0.122*	0.074	0.012	0.075
Intra- and inter-regional ties	0.118*	0.071	0.046	0.193***
Inter-regional ties	-0.019	-0.077	0.004	0.018
Regional R&D spillovers	0.007	0.402***	0.747***	0.084
Sectoral R&D spillovers	0.174*	0.330***	-0.130	0.330***
Size dummy	0.004	0.228***	-0.080	-0.100
Relative % of changed processes and products			0.188*	0.178*
F-value	9.855	29.948	22.500	6.933
Significance of F	0.000	0.000	0.000	0.000
N	224	224	224	224

* = p < 0.10; ** = p < 0.05; *** = p < 0.01