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Determinants of innovative firms' propensity to collaborate across geographical distance

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Abstract

The paper explores the relation between absorptive capacity and the propensity to collaborate across geographical distance. The analysis is based on quantitative data from two neighbouring Danish regions on the location of the main partner in product-innovation activities. The findings indicate that the importance of absorptive capacity in relation to collaboration across geographical distance depends on the location of the innovative firm. Firms located in the relatively sparsely populated region are more likely to collaborate with firms located outside the region; and for these firms, the level of absorptive capacity matters for the distance to the collaboration partners - firms with a low level of absorptive capacity tend to collaborate with domestic partners, while those with a high level of absorptive capacity are much more likely to find their main product-innovation partner abroad.

Keywords: Product Innovation, Distance, Collaboration, Absorptive Capacity.

1. Introduction

To a large degree, innovation management is also a question of managing relations, since innovation is often the outcome of interactive processes (Lundvall, 1985). International surveys show that between 62 and 97 per cent of innovative manufacturing firms have collaborated with external partners on one or more product-innovation projects (Christensen et al., 2001).

Previous studies (Mowery et al., 1996; Lane and Lubatkin, 1998; Nieto and Quevedo, 2005) emphasize how the absorptive capacity of a firm, that is, the ability to recognize the value of, assimilate and apply external knowledge (Cohen and Levinthal, 1990), both the possibilities for collaborative relations and the likelihood of a successful outcome of knowledge-based relations. However, studies of firms' relations have rarely linked absorptive capacity with a geographical dimension in terms of the location of the partner relative to the analysed firms. Doing so may provide new insights into the determinants of a firm's collaboration patterns in relation to innovation.

The main hypothesis of the present paper is that the barriers to acquiring external information to a large extent depend on knowledge and the building up of absorptive capacity (Cohen and Levinthal, 1990), and that it is the latter which determines the distance that firms are willing and able to go to find their most important innovation partners.

The paper is structured in the following way: Section 2 gives a theoretical overview of the role of absorptive capacity and proximity in interactions related to innovation and the development and exchange of knowledge. Section 3 presents the data and empirical model, while Section 4 presents the results of the econometric analysis. Finally, Section 5 presents the conclusion and discusses the implications of the findings.

2. Theoretical considerations on the role of absorptive capacity and proximity for collaboration on innovation

The importance of a firm's location and regional inter-firm relations for knowledge development and diffusion has been acknowledged for some time, as the literature on regional competencies (e.g. Bathelt et al., 2004), industrial districts (e.g. Russo, 1985; Brusco, 1990; Becchetti and Rossi, 2000) and innovative milieus (Camagni, 1991; Ratti et al., 1997) clearly shows. To a large extent, however, the various—often overlapping— strands of literature focus on the same mechanisms for explaining why both unwanted knowledge spillovers and intentional knowledge diffusion/sharing tend to be spatially bounded, and therefore occur more often between closely located firms than between distant firms (the proximity effect on spillovers is, for example, confirmed by Verspagen and Schoenmakers (2004)). These mechanisms include social interactions/informal face-toface interactions, regional labour markets and mobility, as well as region-specific institutions for knowledge accumulation and diffusion.

Geographical proximity, that is, co-location, may be particularly important for the exchange of tacit knowledge (Morgan, 2004). This line of thinking has its roots in evolutionary theories of innovation and technological change, which emphasize the uneven, firm-specific and partly tacit distribution of economic competence. One factor shaping economic competence and relating this to economic space is locationally sticky tacit knowledge. The significance of physical proximity between partners in a knowledge-based project will thus depend on the complexity of the project. This has led to innovation being described as increasingly dependent on a geographically defined infrastructure that can mobilize inputs essential to the innovation process (Feldman and Florida, 1994). Once geographical concentrations of different types of infrastructure are in place, they ‘‘enhance the capacity for innovation as their respective regions develop and specialize in particular

technologie and industrial sectors'' (Feldman and Florida, 1994: 210).[1] Firms located in areas with limited access to external knowledge inputs must therefore either rely on their own internal efforts or face higher costs when acquiring external information.

The notion of industrial districts (see, for example, Russo, 1985) also helps direct attention to the importance of the local knowledge community. The concept of industrial districts was first used by Marshall (1890/1920) to describe the concentration of specialized industries in particular localities. Marshall emphasized the advantages of industries being located in the same region for a long time, allowing ''the mysteries of the trade'' to become un-mystified and something that flows ''in the air'' of the region. Becattini (1979, quoted in Russo, 1985) specifies the special features of the industrial district as a localized thickening of inter-industrial relations. In an industrial district, the interrelations between firms and their proximity to each other provide the basis for the process of generating new techniques within an expanded industry, including machinery, services, etc., related to the core industry (Russo, 1985).

An industrial district primarily defines the vertical and horizontal relations between firms in a specific area, but firms and institutions may also be tied together across industry boundaries, as expressed in a local (or innovative) milieu, where the interaction between economic, socio-cultural, political and institutional actors located in a given place may trigger local learning dynamics (Malmberg et al., 1996). In a local milieu the development of a common code of communication and interaction may improve the fluidity of knowledge, in particular when this is difficult or costly to codify, because a common location will often be synonymous with language and cultural similarities which improve the ease of communication (ibid.). Interactive learning is based on compatible routines, both within and between organizations, as well as tacit norms and conventions that regulate mechanisms for the absorption of tacit knowledge. Spatial proximity is often

[1] Bengtsson and Sölvell (2004), for example, find that relationships with customers and suppliers in a cluster environment influence innovative performance.

considered a key factor for the effective production and sharing of tacit knowledge (Asheim and Gertler, 2005). High levels of interdependence both create and require high levels of trust, mutual obligations and shared expectations among individuals. Relational learning, in terms of creating trust and shared understandings, can require a period of rich communication and active interaction, which may be difficult to achieve if individuals are located far from each other. This is also reflected in arguments put forward by von Hippel (1988, 1994, 1998) that modern ICT does not replace the need for face-to-face communication in complex learning processes. The role of face-to-face interactions as a means of overcoming coordination and incentive problems in uncertain environments may explain why forces of urbanization and location remain strong (Storper and Venables, 2004).

However, as argued by Boschma (2005), while geographical proximity is neither a necessary nor a sufficient condition for interaction, it can facilitate interaction and cooperation through providing a mechanism for coordination. Proximity is not necessarily synonymous with co-location, however. People sharing the same common beliefs, cognitive maps, knowledge base and/or skills may be proximate in a relational (Torre and Rallet, 2005) or cognitive (Boschma, 2004, 2005) way.

The present analysis proposes that absorptive capacity, that is, the ability to evaluate and utilize external knowledge (Cohen and Levinthal, 1990), can contribute to a firm's capabilities to interact with different types of partners, including those located outside the firm's home region. Cohen and Levinthal relate the level of a firm's absorptive capacity to both the formal qualifications of its employees and its R&D activities. A high level of absorptive capacity may reduce problems related to interacting with geographically distant partners, especially in cases where it involves complex knowledge, because by definition absorptive capacity reflects the ability to assess and internalize external knowledge. Firms with a high level of absorptive capacity may therefore be better able to absorb external knowledge than those with a lower absorptive capacity. Establishing and

maintaining external linkages requires substantial time and effort. Linkages are not created automatically and need regular communication and interaction. Owen-Smith and Powell (2004) use the term ‘‘pipelines’’ to denote the channels used in interaction with firms outside the home region. They argue that successful pipelines are costly and time-consuming, that is, in order to communicate and interact with partners outside the home region, trust needs to be developed together with a joint interpretative context and the ability to understand different institutional regimes. Often, the use of pipelines, in terms of combining local with non-local relationships, represents an attempt to overcome identified shortcomings in the local knowledge base and the problem of lock-in. Following the same line of thinking, Bathelt (2003) argues that local relations may be more beneficial when supported by nonlocal relations. The latter may serve to promote new ideas and variety into the region. The cumulative nature of knowledge places firms with a high level of absorptive capacity in a better position to search and find a relevant partner. When a partner has been found, firms with a high level of absorptive capacity are better placed to determine how the knowledge of the partner complements internal knowledge as well as which of the partner’s activities to monitor and control. A relatively high level of absorptive capacity may thus make firms less dependent on local learning dynamics and better able to access the global knowledge pool than firms with a lower level of absorptive capacity. Not only may a high level of absorptive capacity increase firms’ ability to collaborate with distant partners, but such firms also tend to exhaust the local market and be more constrained by the region than firms with a low level of absorptive capacity, which are more likely to satisfy their needs through local interactions.

Thus, the hypothesis to be tested here is that the main innovation partner of firms with a high level of absorptive capacity is likely to be located further away than the main innovation partner of firms with a low level of absorptive capacity.

3. Data and model

The data used in the analysis are based on a survey of product development activities in manufacturing firms (NACE codes 15–36) with at least 10 employees, located in two neighbouring Danish regions: North and East Jutland (see Figure 1). The survey was carried out in 2004.

While a region can be defined in many ways, as is often the case in quantitative studies, this study is based on an administrative definition of a region. The North Jutland region is defined as the County of North Jutland with approximately 495,000 inhabitants, and the East Jutland region as the County of Aarhus with approximately 640,000 inhabitants.

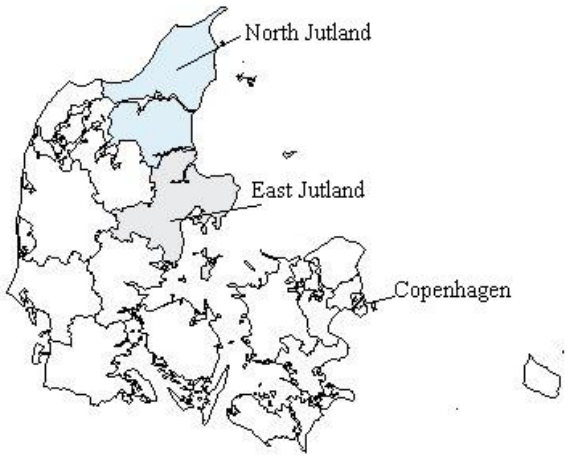

Figure 1 North and East Jutland (Source: Statistics Denmark)

While North Jutland is the larger of the two regions, it is relatively sparsely populated compared with East Jutland. As can be seen from Figure 1, North Jutland is one of the most peripheral regions of Denmark, relative to both the geographical centre of the country and to the capital city of Copenhagen. Neighbouring East Jutland has a slightly more central position, and the region's main city, Aarhus, is considered the ''capital of Jutland''. A comparison of the two regions reveals that

the general level of education is higher in East Jutland than in North Jutland, and that East Jutland also attracts relatively more public and private R&D investments, as well as a larger number of knowledge institutions. The main characteristics of the two regions are summarized and compared with the country as a whole in Appendix Table A1. Since the regions differ in certain aspects that may influence firms' tendency to find partners outside the home region, firm location is controlled for in the analysis.

All firms in the relevant segment in the two regions were targeted in the survey, although it was not possible to reach all of them. Data were collected through computer-aided telephone interviews. A total of 674 firms in the two regions participated in the survey, 331 in North Jutland and 343 in East Jutland. The response rates in the two regions are 79 and 72 per cent, respectively. Only firms that have introduced at least one product innovation in collaboration with an external partner in the 2 years prior to the survey, and have reported their own assessment of the location of their main partner, are included in the following analyses. Since these partners were not approached, the survey contains no additional information about them. The total number of observations is 112 (see Table 1).

Table 1 Overall frequency of product innovation and collaboration* in the two regions

	North Jutland	East Jutland
Product innovation frequency	35% (N=331)	39% (N=343)
Collaboration frequency	56% (N=116)	69% (N=133)
Number of firms that have reported the location of the main partner	50	62

* Collaboration in relation to product innovation.

Due to the complexity of the issue, latent class analysis (Lazarsfeld, 1954) has been used to identify patterns of absorptive capacity. Cohen and Levinthal (1990) relate the level of absorptive capacity to R&D investment and the technical training of employees, as well as to more intangible factors

such as experience and organizational structures. The focus of the present study is on the more tangible—and therefore measurable—aspects of absorptive capacity. The level of absorptive capacity in the individual firms is expressed by three binary variables from the survey: two variables were used to measure the degree of formal qualifications in the firms, one indicating the number of university graduates in the firms' product development staff, and one indicating whether firms use supplementary training in relation to product innovation. The third variable, reflecting the extent of in-house R&D in relation to product innovation, is used as an indicator of firms' R&D activity.

Latent structure analysis allows the basic logic of factor analysis to be applied to qualitative data. The model attempts to account for the observed interrelationships of variables in terms of a few underlying latent dimensions. The latent class model is estimated by maximum likelihood, where the number of classes is determined by goodness-of-fit tests (χ^2 and G^2) as well as two informal information criteria, the Akaike information criterion (AIC) and the Bayesian information criterion (BIC), respectively.

Table 2 shows the latent class estimation with different classes. With respect to the χ^2 and G^2 tests, the latent class model for two classes has the highest level of significance and will be used in the subsequent analysis.

Table 2 Latent class estimation, Goodness-of-fit (p values in parenthesis)

Number of classes	χ^2	G^2	AIC	BIC
1	31.85 (0.000)	31.47 (0.000)	910.30	920.65
2	**12.22 (0.061)**	**12.98 (0.059)**	**887.05**	**911.21**
3	12.98 (0.051)	13.86 (0.051)	902.83	954.59

Table 3 shows the two classes, which can be described in terms of size and profile. The size of the pattern indicates the probability of observing it when a firm is selected randomly from the

population of firms. The profile of the included variables indicates the conditional probability of validating the statements, given the type of pattern.

Class 1 consists of 47.2 per cent of the firms included in the analysis. These firms have the highest probabilities both of having university graduates among their product development staff (74.1 per cent) and of employees participating in supplementary training in relation to product development (58.6 per cent). Finally, these firms are most likely to have carried out in-house R&D in relation to product innovation during the period 2002–2004 (83.9 per cent). This is interpreted as indicating a high level of absorptive capacity.

Table 3 The estimated latent structure with two distinct structures, N=106

Conditional probabilities	Class 1 High absorptive capacity *47.2%*	Class 2 Low absorptive capacity *52.8%*
University graduates employed in product Development	0.741	0.001
Use of supplementary training in product Development	0.586	0.227
In-house R&D	0.839	0.576

Class 2, which is interpreted as the group of firms with a relatively low level of absorptive capacity, accounts for 52.8 per cent of firms in the two regions. These firms have a 0.1 per cent probability of employing university graduates, a 22.7 per cent probability of employees participating in supplementary training and a 57.6 per cent probability of carrying out product-innovation R&D.

The high probability of carrying out innovation-related R&D in both classes indicates that absorptive capacity is more than formal R&D. It is also worth noting that R&D activities do not necessarily require highly educated researchers: even though the survey used the Frascati definition (OECD, 2002) of R&D activities, a considerable proportion of firms without highly educated

development staff reported carrying out systematic R&D activities in relation to their product development activities.

The two types of absorptive capacity regimes will be used in the subsequent analysis to explain firms' propensity to look for their main partners in product-innovation projects across sometimes considerable geographical distances. The descriptive statistics for the two types of classes with respect to location of the main partner, region, size and industry group[2] are shown in table 4. As regards the relation between sector affiliation and level of absorptive capacity, the table shows that it is not only medium-/high-tech industries that have a high level of absorptive capacity: according to the criteria used in the analysis, 67 per cent of firms in medium-/high-tech industries and 33 per cent of firms in low-/medium-tech industries have a high level of absorptive capacity.

Table 4 Descriptive statistics on the estimated latent structure, N=106

	Class 1 - High absorptive capacity	**Class 2 - Low absorptive capacity**
	N=50	*N=56*
Location of most important partner		
- In the region	25.6%	38.8%
- In another region in Denmark	33.3%	37.3%
- Abroad	41.0%	23.9%
Region		
- North Jutland	33.3%	53.7%
- East Jutland	66.7%	46.3%
Size		
50 or more	56.4%	34.3%
- less than 50	43.6%	65.7%
Industry group		
- Medium/high tech	66.7%	56.7%
- Low/medium tech	33.3%	43.3%

[2] Due to the limited number of observations, it is not possible to distinguish between industry affiliations on a more detailed level. The classification of industries is shown in Appendix Table A2.

Multinomial logistic regression techniques are used on the data to explore the covariation between the level of absorptive capacity of an innovative firm (the two latent classes) and the location of its main partner. Feldman (1994) argues that firms will only look outside their local region if the necessary sources for external knowledge inputs are not available locally. An explanatory variable for whether the firms have experienced problems acquiring relevant consulting services in relation to product-innovation activities is therefore also included as an indication of whether firms' expansion of search space is re-active, in the sense that unsatisfied demands ''push'' them to search for partners in more distant locations. However, it should be noted that the question of relevant consulting is not concerned with where firms have searched for this advice. The variable is thus a general expression of experienced problems with finding relevant knowledge/advice.

Finally, the model controls for number of employees,[3] industry affiliation in terms of belonging to a medium-/high- or a low-/medium-tech industry group, and location (i.e. North or East Jutland). As the discussion in Section 2 indicated, the approach is largely explorative, not drawing on a single theory, but combining the theoretical considerations behind concepts such as absorptive capacity, (technological) geographical infrastructure and different types of proximity.

The basic structure of the model applied in the subsequent analysis can be specified as follows:

$$a = f\left(\beta_{1z} + \beta_{2q}\right) \qquad (1)$$

where a represents the firms' propensity to cross geographical distance to find partners in product-innovation projects, z is a vector for absorptive capacity and experienced problems with acquiring relevant consulting services, and q is a vector for control variables.

Parameter a is measured on a three-point scale ranging from having the main partner in the home region (used as the benchmark category in the analysis), having the main partner in another region

[3] Small firms may be more dependent on the local technological infrastructure because they are less able than large firms to internalise innovative inputs and provide complementary activities that facilitate innovation (Feldman, 1994).

in Denmark, to having the main partner outside Denmark. The model does not apply to the total partner portfolio of the innovative firms, since detailed information on partner location is only available for the main partner. Notwithstanding, it is possible to determine whether the total partner portfolio consists of national partners only, foreign partners only or a mix of national and foreign partners. Table 5 shows that there is a relation between location of the main partner and total partner portfolio in the sense that one-third of the firms that find their main partner in their home region or within Denmark have only Danish partners in their partner portfolio. On the other hand, the fact that the majority of firms have a mix of Danish and foreign partners indicates that most of the collaborating innovative firms combine local/national relations with more distant relations. According to Boschma (2005), this is a viable strategy for promoting new ideas in a region (see Section 2 above). However, focusing on the geographical distance to the main partner—as in the present study—is relevant based on the assumption that this partner also supplies the most important knowledge input, involving more learning, and depending more on trust, than less important partners.

Table 5 Relation between location of main partner and nationality of total partner portfolio.

	Location of main partner			
	Same region	Other region in Denmark	Abroad	Total
Danish partners only	35%	33%	0%	24%
foreign partners only	0%	0%	15%	5%
Danish and foreign partners	65%	67%	85%	72%
N	37	39	34	110

NB: Two observations have been omitted from the table due to inconsistent information.

Turning to the explanatory variables, *z* can be decomposed into two variables, the first being a dummy for the two classes from the latent class analysis measuring the absorptive capacity of the

firms. The second variable is also a dummy, and indicates whether firms have experienced problems in acquiring relevant consulting services in relation to product innovation activities. Finally, *q* can be decomposed into the traditional control variables size and industry affiliation, as well as a dummy variable for the region where the firm is located.[4]

4. Results of the regression analysis

Table 6 presents the results of the multinomial logistic regression model described above. As can be seen from the overall statistics, the model, which examines co-variation between the dependent and independent variables, appears to fit well. The log likelihood ratio rejects the hypothesis that the coefficients of the variables are all zero.

Starting with national collaboration (intra- and interregional), the model shows that firms with a high level of absorptive capacity are no likelier to collaborate with firms outside their home region than firms with a low level of absorptive capacity. As regards collaboration with partners located abroad, however, firms with a high level of absorptive capacity are 2.75 times more likely to engage in such cross-border collaboration than firms with a low level of absorptive capacity. The positive and significant estimate for absorptive capacity in relation to collaboration with foreign partners supports the assumption that firms with a high level of absorptive capacity are more inclined to absorb external knowledge. Such firms are better able to search and find the most relevant partner. Moreover, both relational learning and establishing ‘‘pipelines’’ is easier for these firms, which increases the ability to interact with geographically distant partners. This result agrees with Giuliani and Bell (2005), who, by analysing social network data for firms in a Chilean wine cluster, find that

[4] Collaboration with parent/subsidiary company was also tested as a control variable, but was shown to be insignificant in the multinomial regression model and is thus omitted from the analysis.

firms with a high level of absorptive capacity are more likely to establish linkages with firms outside the cluster.

Table 6 Regression results, model 1

Variables	Coef.	Std.Err.	Odds ratio
Main partner in another Danish region			
Intercept	*-0.92	0.54	
Absorptive capacity			
- High	0.51	0.55	1.67
- Low		Benchmark	
Problems of finding relevant consulting services			
- Yes	*1.24	0.74	3.47
- No		Benchmark	
Size			
- 50 or more employees	0.33	0.52	1.39
- less than 50 employees		Benchmark	
Industry			
- Medium-/high-tech	0.13	0.49	1.14
- Low-/medium-tech		Benchmark	
Region			
- North Jutland	**1.07	0.52	2.91
- East Jutland		Benchmark	
Main partner abroad			
Intercept	***-2.48	0.71	
Absorptive capacity			
- High	*1.01	0.58	2.75
- Low		Benchmark	
Problems of finding relevant consulting services			
- Yes	**1.87	0.79	6.51
- No		Benchmark	
Size			
- 50 or more employees	**1.26	0.58	3.52
- less than 50 employees		Benchmark	
Industry			
- Medium-/high-tech	0.70	0.57	2.01
- Low-/medium-tech		Benchmark	
Region			
- North Jutland	**1.45	0.58	4.26
- East Jutland		Benchmark	
N		106	
Nagelkerke pseudo R-square		0.22	
Log likelihood		106.02	

Notes: *** significance at 1% level; ** significance at 5% level; * significance at 10% level.
Six observations are missing due to item non-response.
Notes: There is no serious sign of multicollinearity between the independent variables. The multicollinearity is estimated by using the predicted probabilities of the dependent variables. The predicted variables are then used to construct a weighted variable, which is applied in a weighted least squares regression. A tolerance is computed by regressing each variable on all the other explanatory variables.

Firms that have experienced problems with finding relevant consulting services in relation to product development are more likely to find partners outside their home region than firms that have

not experienced such problems. This applies to partners located in another domestic region as well as abroad. This may support the argument by Feldman (1994) that collaborating across distance is largely a re-active action that occurs when knowledge resources are weak in the home region. However, as mentioned earlier, this variable does not have a geographical dimension and should therefore be interpreted with caution.

Size effects are only significant in relation to collaboration with partners located abroad, where, as one would expect, it is the larger firms that are most likely to collaborate with foreign-based partners. The industry effect is not significant. The last control variable is the home region of the product-innovative firm. Firms in North Jutland are 2.91 times more likely to collaborate with a partner located in another Danish region, and 4.26 times more likely to collaborate with a foreign partner, compared with firms in East Jutland. There is thus a very strong regional effect, which raises the question of whether the role of absorptive capacity can be considered the same in the two regions, considering these marked differences in collaboration patterns. The possible interplay between home region and level of absorptive capacity can be explored in a new model by replacing the variables for region and absorptive capacity in the original model by a constructed interaction variable, which combines the effects of the two original variables. The results of the regression analysis of this new model are shown in Table 7.

Table 7 shows that there is indeed an interaction effect between region and level of absorptive capacity. With respect to collaboration with domestic partners outside the innovative firm's home region, it is only the combined effect of low absorptive capacity and location in North Jutland that is significant. This means that, compared with the benchmark, that is, firms with a low level of absorptive capacity located in East Jutland, firms with a low level of absorptive capacity located in North Jutland are more likely (by a factor 4.07) to find their main partner in another Danish region.

Table 7 Regression results, model 2

Variables	Coef.	Std.Err.	Odds ratio
Main partner in another Danish region			
Intercept	*-1.14	0.59	
Region and absorptive capacity			
- North Jutland and high absorptive capacity	1.08	1.02	2.95
- North Jutland and low absorptive capacity	**1.40	0.61	4.07
- East Jutland and high absorptive capacity	0.91	0.65	2.48
- East Jutland and low absorptive capacity		Benchmark	
Problems of acquiring relevant consulting services			
- Yes	*1.24	0.75	3.46
- No		Benchmark	
Size			
- 50 or more employees	0.37	0.53	1.45
- less than 50 employees		Benchmark	
Industry			
- Medium-/high-tech	0.14	0.50	1.14
- Low-/medium-tech		Benchmark	
Main partner abroad			
Intercept	***-2.34	0.74	
Region and absorptive capacity			
- North Jutland and high absorptive capacity	**2.15	0.97	8.60
- North Jutland and low absorptive capacity	*1.29	0.71	3.65
- East Jutland and high absorptive capacity	0.85	0.72	2.34
- East Jutland and low absorptive capacity		Benchmark	
Problems of acquiring relevant consulting services			
- Yes	*1.86	0.79	6.44
- No		Benchmark	
Size			
- 50 or more employees	**1.22	0.58	3.38
- less than 50 employees		Benchmark	
Industry			
- Medium-/high-tech	0.70	0.57	2.03
- Low-/medium-tech		Benchmark	
N		106	
Nagelkerke pseudo R-square		0.23	
Log likelihood		104.37	

Notes: *** significance at 1% level; ** significance at 5% level; * significance at 10% level.
Six observations are missing due to item non-response.
Notes: There is no serious sign of multicollinearity between the independent variables. The multicollinearity is estimated by using the predicted probabilities of the dependent variables. The predicted variables are then used to construct a weighted variable, which is applied in a weighted least squares regression. A tolerance is computed by regressing each variable on all the other explanatory variables.

With respect to collaboration with partners located abroad, there are no significant differences between firms with high and low levels of absorptive capacity located in East Jutland—as was the case with collaboration with partners located in another Danish region. But for firms located in North Jutland there are significant effects for firms with low as well as high levels of absorptive capacity. The weakest effect, significant at a 10 per cent level only, is for firms with a low level of

absorptive capacity. These firms are 3.65 times more likely to collaborate with firms located abroad than their counterparts in East Jutland. The effect for firms in North Jutland with a high level of absorptive capacity is very large—these firms are 8.60 times more likely to collaborate with firms located abroad than the benchmark firms in East Jutland. These results indicate that even relatively limited differences between regions matter for the geography of collaboration patterns of product-innovative firms.

The fact that firms located in North Jutland are more likely to find their main partners outside their home region than firms in East Jutland, regardless of level of absorptive capacity, is—following the propositions of Feldman—likely to be caused by the region being less well equipped to meet the need for external inputs of product-innovative firms. And for firms which do find it necessary to go outside the region to find knowledge partners, the results of the present analysis indicate that the level of absorptive capacity of the innovating firm matters for the distance it is likely to cross to find its main partner. These findings are summed up in Table 8.

Table 8 Relation between level of absorptive capacity and probable location of the main partner in relation to product innovation – *given that the relevant partners are not available in the home region*

Level of absorptive capacity	High	Tendency to find main partner *abroad*
	Low	Tendency to find main partner in *another domestic region*

Regarding the other variables included in the analysis, for instance, problems with acquiring the relevant consulting services, firm size and industry, the findings are similar to those in model 1.

5. Conclusions

The main purpose of the present paper has been to improve our understanding of the geographical and cognitive limits of firms' collaboration strategies in relation to innovation by relating the absorptive capacity of product-innovative firms to their inclination to cross geographical distance to find their main innovation partners.

The analysis confirms that absorptive capacity, measured in terms of employee qualifications as well as formal R&D activities, is an important resource with regard to close interaction with geographically distant partners—albeit primarily when local knowledge sources are lacking. This means that, of the firms located in the relatively peripheral and sparsely populated region of North Jutland, those with a low level of absorptive capacity tend to find their main partner outside the home region but within the country, whereas firms with a high level of absorptive capacity are more inclined to find their main partner abroad. The cumulative nature of knowledge in building up absorptive capacity makes these firms more able to determine where to find relevant partners. Once the partner is found, the creation of pipelines in terms of developing trust and a joint interpretative context is crucial, since pipelines may contribute to decisive, non-incremental knowledge flows (Bathelt et al., 2004).

This implies that investments in highly skilled employees, supplementary training and in-house R&D expenditures influence a firm's ability to join international collaborative networks for product innovation. If the firm does not possess these internal capabilities, then the barriers for participating in international collaborations tend to be too high to overcome. Finding these results for two neighbouring regions in a small country is interesting and supports those scholars who maintain that, even in the age of globalization, geography still matters (see, for example, Morgan, 2004). Furthermore, being able to participate in a global knowledge exchange requires a strong internal knowledge base in the individual firms.

Several questions regarding inter-firm collaboration across geographical distance still remain unanswered. In the present analysis, for example, it is not possible to say anything about which type of partners firms look for locally and more distantly, respectively, nor what the outcome of different collaboration strategies is. For example, it is not possible to determine whether one collaboration strategy—e.g. collaborating with foreign partners—is better than another. Following Nooteboom et al. (2005), one would expect that collaboration with more distant partners—measured in geographical as well as cognitive terms—would be more explorative than collaboration with more local partners, where the focus can be expected to be more on exploitation of existing knowledge (incremental innovations). In the latter case it is primarily routine learning that takes place, which adds little to the knowledge base of the firm. In such circumstances, a strong mutual understanding between the firms involved in the collaboration project is needed in order to coordinate rapidly and avoid errors. In explorative projects, where there is no dominant design but a shift away from existing rules, norms and routines, firms have to develop ideas which go beyond the limitations of a contextually localized search. On the other hand, as stressed by, for example, Asheim and Getler (2005), tacit—and complex—knowledge tends to be locationally sticky, thus arguing for an important role for proximity in projects involving the exchange of complex knowledge. One avenue for further research could therefore be a more detailed qualitative analysis of which types of innovation projects firms with high and low levels of absorptive capacity participate in; firms' rationale for participating in different types of collaborations; which types of partners are sought under which circumstances; and how the search processes are actually carried out.

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The title of this paper was inspired by Laursen and Salter (2004), who use the phrase ''Searching Low and High'' to describe how firms' innovation activities draw on knowledge created at

universities (the ‘‘high’’ end of knowledge). Laursen and Salter thus look at different types of partners, whereas the present paper looks at where partners are located. The authors appreciate valuable comments on earlier versions of this paper from participants at an IKE seminar at Aalborg University; the DRUID summer conference 2005, in particular Jens Frøslev Christensen and Fiorenza Belussi; the 18th Scandinavian Academy of Management (NFF) meeting; the Jena Workshop on Regional Innovativeness—Mechanisms of Knowledge Flows and Accumulation; as well as two anonymous referees. The usual disclaimer applies.

References

Analyseinstitut for Forskning 2003a, *Erhvervslivets forskning og udviklingsarbejde. Forskningsstatistik 2001*, Århus, Analyseinstitut for Forskning.

Analyseinstitut for Forskning 2003b, *Forskning og udviklingsarbejde i den offentlige sektor. Forskningsstatistik 2001*, Århus, Analyseinstitut for Forskning.

Asheim, B.T. & Gertler, M.S. 2005, ‘The geography of innovation. Regional innovation systems’ in *The Oxford Handbook of Innovation,* eds. J. Fagerberg, D.C. Mowery, D.C. & R.R. Nelson, Oxford University Press, Oxford.

Bathelt, H. 2003, ‘’In Good Faith?’ The ‘Distanced Neighbor’ Paradox: ‘Over-embedded’ and ‘Under-Socialized’ Economic Relations in Leipzig’s Media Industry’, *European Regional Association Conference*, Piza, Italy

Bathelt H., Malmberg, A. and Maskell, P., 2004 ‘Clusters and Knowledge: Local Buzz, Global Pipelines and the Process of Knowledge Creation’, Progress in Human Geography, vol. 28, no. 1, pp. 31-56

Becattini, G. 1979, ‘Dal 'settore' industriale al 'distretto' industriale: alcune considerazioni sull'unità d'indagine dell'economia industriale’, *Rivista di Economia e Politica Industriale.*

Becchetti, L. and Rossi, S. P. S. 2000, ‘The Positive Effect of Industrial District on the Export Performance of Italian Firms’, *Review of Industrial Organization,* vol. 16, no. 1, pp. 53-68.

Bengtsson, M. & Sölvell, Ö. 2004, ‘Climate of competition, clusters and innovative performance’, *Scandinavian Journal of Management*, vol. 20, no. 3, pp. 225-244.

Boschma, R. 2004, ‘Does geographical proximity favour innovation?’, *The 4th congress on Proximity Economics,* Marseilles, France.

Boschma, R.A. 2005, ‘Proximity and Innovation: A Critical Assessment’, *Regional Studies*, vol. 39, no. 1, pp.61-74.

Brusco, S. 1990, ‘The Idea of the Industrial District: Its Genesis’, in *Industrial Districts and Inter-Firm Co-operation in Italy*, eds. F. Pyke & G. Becattini & W. Sengenberger, International Institute for Labour Studies, Genova.

Camagni, R. 1991, *‘Innovation Networks: Spatial Perspectives’*, Cambridge, MA, and London: Harvard University Press.

Christensen, J.L., Schibany, A., Vinding, A. L. 2001, 'Collaboration between Manufacturing Firms and Knowledge Institutions on Product Development: Evidence From Harmonised Surveys in Australia, Austria, Denmark, Norway and Spain', in *Innovative Networks*, OECD, Paris.

Cohen, W. & Levinthal, D. 1990, 'Absorptive Capacity: A New Perspective of Learning and Innovation', *Administrative Science Quarterly*, vol. 35, no. 1, pp. 128-152.

Feldman, M.P. 1994, *The Geography of Innovation*, Kluwer Academic Publishers, Dordrecht.

Feldman, M.P. & Florida, R. 1994, 'The Geographic Sources of Innovation: Technological Infrastructure and Product Innovation in the United States', *Annals of the Association of American Geographers*, vol. 84, no. 2, pp. 210-229.

Giuliani, E. Bell, M. 2005, 'The Micro-determinants of Meso-level Learning and Innovation: Evidence from a Chilean Wine Cluster', *Research Policy*, vol. 34, pp47-68

Lane, P. & Lubatkin, M. 1998, 'Relative Absorptive Capacity and Interorganizational Learning', *Strategic Management Journal*, vol. 19, no. 5, pp. 461-477

Laursen, K. & Salter, A. 2004, 'Searching Low and High: What Types of Firms Use Universities as a Source of Innovation?', *Research Policy*, vol. 33, no. 8, pp. 1201-1215.

Lazarsfeld, P.F. 1954, 'A Conceptual Introduction to Latent Structure Analysis', in *Mathematical Thinking in the Social Sciences*, Russell&Russell, New York.

Lundvall, B.-Å. 1985, *Product Innovation and User-Producer Interaction*, Aalborg University Press, Aalborg.

Malmberg, A., Solvell, O. & Zander, I. 1996, Spatial Clustering, Local Accumulation of Knowledge and Firm Competitiveness, *Geografiska Annaler, Series B, Human Geography*, vol. 78, no. 2, pp. 85-97.

Marshall, A. 1890/1920, *Principles of Economics*, 8 ed., Macmillan, London.

Morgan, K. 2004, 'The exaggerated death of geography: learning, proximity and territorial innovation systems', *Journal of Economic Geography*, vol. 4, no. 1, pp. 3-21.

Mowery, D. C., Oxley, J. E. & Silverman, B. S. 1996, 'Strategic Alliances and Interfirm Knowledge Transfer', *Strategic Management Journal*, vol. 17, winter special issue, pp. 77-91

Nieto, M. & Quevedo, P. 2005, 'Absorptive Capacity, Technological Opportunity, Knowledge Spillovers, and Innovative Effort', *Technovation*, vol. 25, no. 10, pp. 1141-1157

Nooteboom, B., Vanhaverbeke, W., Duysters, G., Gilsing, V. & Oord, A. 2005, 'Optimal Cognitive Distance and Absorptive Capacity', *Eindhoven Centre for Innovation Studies Working paper 05.04*, Department of Technology Management, Eindhoven University of Technology.

OECD 2002, *Frascati Manual 2002: Proposed Standard Practice for Surveys on Research and Experimental Development*, OECD, Paris.

Owen-Smith, J. Powel, W., 2004,' Knowledge Networks as Channels and Conduits: The Effects of Spillovers in the Boston Biotechnology Community', *Organization Science*, vol. 15, no. 1, pp. 5-21

Ratti, R., Bramanti, A., Gordon, R., 1997, 'The Dynamics of Innovative Regions: The GREMI Approach', Aldershot and Brookfield

Russo, M. 1985, Technical change and the industrial district: The role of interfirm relations in the growth and transformation of ceramic tile production in Italy, *Research Policy*, vol. 14, no. 6, pp. 329-343.

Storper, M. & Venables, A.J. 2004, 'Buzz: face-to-face contact and the urban economy', *Journal of Economic Geography*, vol. 4, no. 4 pp. 351-370.

Torre, A. & Rallet, A. 2005, 'Proximity and Location', *Regional Studies*, vol. 39, no. 1, pp. 47-59.

Verspagen, B. & Schoenmakers, W. 2004, 'The spatial dimension of patenting by multinational firms in Europe', *Journal of Economic Geography*, vol. 4, no. 1, pp. 23-42.

von Hippel, E. 1988, *The Sources of Innovation*, Oxford University Press, New York.

von Hippel, E. 1994, '"Sticky Information" and the locus of problem solving', *Management Science*, vol. 40, no. 4, pp. 429-439.

von Hippel, E. 1998, 'Economics of product development by users: The impact of "sticky" local information', *Management Science*, vol. 44, no. 5, pp. 629-644.

Appendix

Table A1 Main characteristics of North Jutland and East Jutland

	North Jutland (peripheral region)	East Jutland (central region)	Denmark
Inhabitants	495,000	640,000	5,400,000
Main city (inhabitants in brackets)	Aalborg (162,000)	Aarhus (291,000)	Copenhagen (502,000)
Private R&D expenditure per 1,000 inhabitants[a]	DKK 4.0 mil.	DKK 4.5 mil.	DKK 4.1 mil.
Public R&D expenditure per 1,000 inhabitants[a]	DKK 3.9 mil.	DKK 7.2 mil.	DKK 5.9 mil.
R&D in technical and natural sciences as a percentage of total public R&D expenditure[b]	54%	31%	40%
Employment in business services as a percentage of total employment[c]	7.3%	9.6%	9.3%
Percentage of population with higher education[d]	17.8%	23.5%	21.2%
Percentage of unskilled workers in the population[d]	44.4%	41.2%	42.0%
Main knowledge institution(s)[d]	Aalborg University: 13,000 students	Aarhus University: 20,500 students; Aarhus School of Business: 6,000 students; University College of Engineering: 1,400 students	Copenhagen University: 36,000 students; University of Southern Denmark: 16,000 students; Copenhagen Business School: 15,000 students; Roskilde University: 8,700 students: Denmark's Technical University: 6,000 students Royal Veterinary and Agricultural University: 3,100 studens

a. Source: Based on www.nja.dk, www.aaa.dk, Statistics Denmark and Analyseinstitut for Forskning (2003a; 2003b).
b. Analyseinstitut for Forskning (2003b)
c. Source: Statistics Denmark, StatBank Denmark (RAS4).
d. Source: Statistics Denmark, StatBank Denmark (HFU2).
e. Source: Individual institutions' homepages.

Table A2: Classification of industries according to low-/medium- and medium-/high-technology sector (NACE codes)

Low/medium	**Medium/high**
15-16: Food, beverage and tobacco	21-22: Paper products, printing and publishing
17-19: Textiles, wearing app., leather	24: Chemicals and man-made fibres
20: Wood and wood products	25: Rubber and plastic products
26: Other non-metallic mineral products	29: Machinery
27-28: Processing of basic metals	30-34: Electrical and optical equipment
35: Transport equipment	
36: Furniture, manufacturing nec.	