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Climate of competition, clusters and innovative performance

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Abstract

The aim of this paper is to examine industry competition and cooperation in industry clusters, and to explore the role they play in driving innovation among firms. The dependent variable, innovative performance, is measured in terms of both product and process development. A theoretical model is built on the basis of three constructs: industry competition, involving both structural and relational, or 'climatic' characteristics; industry cluster; and innovative performance. Seven hypotheses are extracted from the model. A LISREL model based on a stratified sample of all Swedish manufacturing industries is used to test our hypotheses. The empirical findings have important theoretical implications in three areas. First, by introducing relational dimensions of competition—the 'climate of competition'—we can build a more refined model of the nature of industry competition. Two types of climate are identified, the 'hot' and the 'cold'. Second, it is shown that the structure and climate of competition are both important drivers of innovative behavior. Third, in addition to competition, cooperation within clusters also has a significant impact on innovation.

Keywords: Competition; Industry structure; Climate of competition; Cooperation; Cluster; Innovation

1. Introduction

In recent studies focusing on competitive advantage, that is to say on the way firms sustain and enhance their competitive positions, innovation in the broadest sense has

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become a topic of prime concern. A renewed interest in basic competition has directed attention towards factors beyond the individual firm as key elements in driving innovation. These factors may include competitive pressures as well as elements of cooperation. The industrial conditions in which firms operate may be fairly conducive to innovation or they may be less so, and this paper suggests that the level of innovative performance is closely linked to various aspects of the local competitive setting of the particular firm.

The question of localized innovation processes, in the context of competition and cooperation within clusters, has been attracting growing interest among researchers (for an overview, see Malmberg, Sölvell, & Zander, 1996). The notion of spatial agglomeration is a central theme in economic geography (Piore & Sabel, 1984; Storper, 1995). However, most of these models are primarily preoccupied with optimization and flexibility within local production systems. More recent works, building on Marshall's early writings (Marshall, 1890/1916), have switched the focus towards learning, creativity and innovation within regions or local clusters (Porter, 1990; Krugman, 1991; Saxenian, 1994). A local industry cluster (Porter, 1990; Enright, 1991) embraces linked industries and institutions such as buyers, specialized input suppliers, service providers, specialized education and research institutions and industries in related technologies.

In these models the level of innovative performance among firms is typically explained in terms of the intensity and diversity of competition, and the nature of the relationships with firms such as customers and suppliers within the local network. Hence, it is claimed that localized innovation processes are driven by the pressures provided by competition as well as synergies arising from cooperation. Industry competition includes traditional structural dimensions such as the number and the size distribution of firms, symmetry, product differentiation and vertical integration (cf. Bain, 1956; Scherer, 1980; Tirole, 1988). Theories on localized innovation processes have added a spatial dimension to competition. It is argued that the intensity and quality of competition is enhanced by the proximity of competitors, as in the case of the IT industries in Silicon Valley, or within film-related industries in Hollywood. Porter (1990) pointed out that the interplay among geographically proximate competitors operating under the same cultural conditions, speaking the same language and so on, develops a more dynamic competitive situation. Further, he claimed that psychological factors such as prestige and pride stimulate companies to compete actively and to become more innovative. Thus, the pressures provided by competition include dimensions other than the purely structural and spatial and, as we will argue in this article, these relational dimensions have not yet been fully scrutinized.

By adding relational and perceptual dimensions, i.e. the 'climate of competition' to the discussion we believe that a more discriminative picture of competition can be achieved. Ideas regarding the climate of competition are related to earlier seminal work on 'industry recipes' (Spender, 1989), 'industrial wisdom' (Hellgren & Melin, 1992) and 'mental models' of competition (Porac, Thomas, Wilson, Paton, & Kanfer, 1995). These relational and perceptual dimensions of competition have been discussed, but only implicitly, in theories on localized innovation processes. We

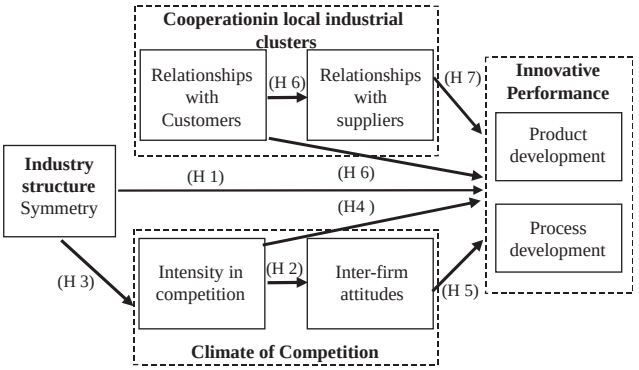

Fig. 1. Theoretical model for the study.

argue that the climate of competition is a crucial ingredient in the overall pressure of competition, and we will thus look further into these dimensions, and will measure their impact on innovative performance.

A complex phenomenon such as innovative performance needs explaining in terms of a multifarious set of factors. The level and character of competition will be measured together with cooperative relationships with customers and suppliers within clusters. A structural equation model (LISREL) is used to measure the way various competitive and cooperative forces in the local environment affect innovative performance within industries. Our purpose is to test seven hypotheses regarding competitive pressures on the one hand and the importance of cooperative relationships with customers and suppliers, on the other hand, and the role they play in driving innovation (see Fig. 1).

The article is structured as follows. First, we will briefly introduce the theme of innovative performance in terms of both product and process development. Second, we will build a theoretical model based on seven hypotheses regarding (1) the inter-relationships between structural and climatic dimensions of competition, (2) the relationships between competition and innovative performance, and (3) the relationships between cooperation within clusters and innovative performance. Thereafter, we build a LISREL model to test our hypotheses, and then discuss the findings. Finally, we draw some conclusions regarding local conditions for innovation.

2. The location of innovation processes

In the literature of International Business literature, it has been proposed in some quarters that innovation is currently assuming more global forms (Nohria & Ghoshal, 1997; Ghosal & Bartlett, 1990; Dunning, 1993; Hedlund, 1986, 1994). Other researchers have argued that although transnational firms are spanning the

globe, innovation processes tend to remain within clusters of firms and industries in close proximity with one another (Enright, 1991; Sölvell, Zander, & Porter, 1991; Porter, 1990).

Arguments in favor of the local innovative environment include the benefits of labor pooling (Dumais, Ellison, & Glaeser, 1997), specialized suppliers, and intense rivalry (Audretsch & Feldman, 1996; Porter, 1990). The mobility of engineers is typically greater within a single geographical area than between different areas (Angel, 1989). Specialized suppliers provide a local industrial infrastructure that is important to the firms. Venture capitalists gather in areas where successful companies are already located and the formation of new firms is intense in 'hot spots' (Pouder & St John, 1996). When ideas are developed and are realized as products, lead customers are then often available nearby.

It is within these clusters or 'innovation communities' that much of the development and commercialization of new technologies take place (Lynn, Reddy, & Aram, 1996) The quality of the local environment also sharpens the struggle between competitors. Porter (1990) claims that competition acts as a catalyst in dynamic clusters: competitors spur each other to improve their products and processes, to compete for the best engineers and venture capital, and to jostle for cooperative relationships with suppliers and customers. Zander and Sölvell (1991) argue that centers of excellence within multinational firms reinforce these localized innovation processes.

Dynamic local environments thus foster innovative performance, but there is reason to assume that the innovation processes differ in kind (cf. Nooteboom, Jong, Vossen, Helper, & Sako, 2000). Henderson and Clark (1990) describe architectural innovations, that is to say those entailing the reconfiguration of elements or activities, as radical. Incremental innovations on the other hand entail novel features but maintain the existing architecture. The distinction between radical and incremental technological development recalls the exploration–exploitation divide introduced by March (1991). Cooper and Schendel (1976) find that the development or acquisition of totally new technological competencies is critical to the prosperity and survival of firms. Along with looking at the degree of novelty in innovations, the relevant studies make a fundamental distinction between product development and process development (Utterback & Abernathy, 1975).

3. Drivers of innovative performance: a theoretical model

In our model, a distinction is made between competition and cooperation in the local industrial setting, embracing three dimensions of competition and two dimensions of cooperation. Competition is described from an industry-structure perspective in terms of the degree of *symmetry* between competitors, and from a relational perspective in terms of the *intensity* of the competition and the *hostility* of inter-firm relationships. Cooperation is described in terms of close and demanding relationships with *customers* and *suppliers*. Several hypotheses are derived regarding the relation between certain aspects of the local industrial setting and the level of innovative performance and these are then used to build a structural equation model.

3.1. Competition—structural dimensions

Characteristics of industry structure are described and analyzed on the basis of the well-established Industrial Organization (IO) paradigm, and structural conditions are assumed to determine performance (Bain, 1959; Scherer, 1980; Tirole, 1988; Schmalensee, 1988). Discussion of performance has generally revolved around monopoly rents, while less has been said about innovative performance. One important exception here is Schumpeter (1942), where it is claimed that concentrated industries, consisting of a few symmetrical firms of roughly the same size and operating with R&D departments of critical mass, will turn in a good innovative performance (cf. Schmalensee, 1988; Arrow, 1962). The degree of strategic similarity among competitors affects the way the firms in question will interact, thus also explaining how the competitive elements in the local environment encourage innovative performance. The degree of similarity has been addressed in theoretical discussions on symmetry within industries. Resource asymmetry within industries was first modelled by Chamberlin (1933). Within the IO framework, symmetry became even more central to the analysis with the advent of strategic group models and the notion of mobility barriers (Hunt, 1972; Caves & Porter, 1977). Strategic groups of firms can be identified by similarities and dissimilarities in the strategic actions of the constituent firms (Barney & Hoskisson, 1990). According to Chen (1996), competitors can be said to be symmetric when they operate in the same market segments, using the same resources. Only then do competitors actually compete with each other directly.

In the theory of strategic groups it has been argued that a high degree of symmetry will increase the likelihood of tacit collusion, thus reducing the intensity of the competition (Caves & Porter, 1977). The opposite hypothesis has also been put forward in the IO field. Kwoka (1979), Kwoka and Ravenscraft (1986) argue that problems of coordination can arise among a smaller number of companies, and that symmetry in company size produces active competition. Porter (1979) has also argued that symmetry within a strategic group can increase competition: since competitors have failed to differentiate their products, they are more likely to enter into price wars. Symmetric firms tend to compare themselves constantly with each other. The result will be a situation of intense rivalry, where moves and countermoves are frequent, creating a more dynamic industrial setting. This leads us to the following hypothesis:

Hypothesis 1 Symmetry among competitors is positively associated with (a) product development, and (b) process development.

3.2. Competition—climatic dimensions

To get a better idea of how competition works as a driver of innovation, we have added some further dimensions to the purely structural ones included in the analysis. We believe that the concept of the 'climate of competition' (Bengtsson, 1998) can

usefully extend our understanding of competition. Climate has traditionally been studied at the level of the organization (cf. Reidenbach & Robin, 1991; Miller, 1997; Brown, 1998; Nicholson, 1998; Minkes, Small, & Chatterjee, 1999), but climatic dimensions can also be found in relationships at the inter-organizational level. Studies of dyadic relationships formed during negotiations (Aquino, 1998; Butler, 1999), of 'atmospheres' in networks (Håkansson, 1982), and of innovative climates (Oesterle, 1997), show that climatic dimensions do impact relationships between organizations.

Although researchers have defined climates in different ways, a common denominator emerges: that climates are based on formal and informal beliefs, values and norms, all of which develop in social settings, and that these beliefs, values and norms are related to the way individual people act (Bennis & Nannus, 1985; Trevino, 1986; Kelly & Dorsch, 1991; Cohen, 1995; Agarwal & Malloy, 1998; Chatterjee, 1998). Since competition consists basically of the inter-firm interaction arising from the actions and counter-actions of individuals or groups of individuals in competing firms, it can be said that competition occurs in a social setting. This is consistent with such concepts as 'industry recipes' (Spender, 1989), 'industrial wisdom' (Hellgren & Melin, 1992; Melander, 1997), and 'mental models' (Porac et al., 1995), all of which are described as a set of collective perceptions governing competitive interaction. The beliefs, values and norms of firms, as well as the way they act, are then all affected by the interactions and interpretations of the firms concerned (Bogner & Thomas, 1993; Fumbrun & Zajac, 1987; Reger & Huff, 1993). Interaction can vary in its intensity, giving rise to different attitudes towards competitors and their actions, and different ways of evaluating these. The intensity of the competitors' interactions and the type of norms and inter-firm attitudes that prevail among them, will all help to shape the climate of competition. Aspects like these are more apparent in local competitive settings, thus introducing into industry competition in local environments a quality not previously scrutinized.

The intensity of competition refers to the frequency of the moves and counter-moves. Intensity is low if competitors coexist, and the actions of one competitor do not lead to counter-moves by others (Easton & Araujo, 1992). This may be due to a tacit understanding that in the end all firms will lose from confrontation. In some industries, however, intense competition develops as firms frequently counter-act each others' moves. The degree of intensity in competition is related to the level of hostility between competitors. The level of hostility in turn can be gauged by considering the perceptions the firms have of each other and the type of actions they take vis-à-vis the others. Competing firms may see each other as 'friends' or 'enemies', they may 'love' or 'hate' each other and so forth, and will then act accordingly. The distinction between friendly and hostile competition accords well with Easton's (1987) distinction between competition and conflict, where conflict implies that firms interact with a view to destroying their competitors. The level of hostility can be expected to vary with the intensity of the competition. Industry recipes and common mental models change with the competitive intensity, ranging from a 'gentleman's club approach to one of increasing hostility (D'Aveni, 1994). Thus, the more intense the competition becomes, the more 'friendly competition' will

have to give way to 'hostile competition'. Our second hypothesis accordingly runs as follows:

Hypothesis 2 Intense competition is negatively associated with friendly inter-firm values.

The climate of competition is seen as a variable in between industry structure and innovative performance. Structure is assumed to impact the way in which competitors interact with each other, as well as inter-firm attitudes (Schmalensee, 1988; Easton, 1987). A common theme in studies of strategic groups is that the intensity of the competition is related to the degree of product and market symmetry between companies. Competitors that are symmetric, i.e. operating in the same product and market segments, are said to be strategically proximate, i.e. they constantly interact with each other, thus increasing the intensity of the competition (cf. Chen, 1996). Cool and Dierickx (1993) argue that if the available resources and the ability to act are equal between companies, i.e. the symmetry between them is high, then the companies will repeatedly contest each others' product and market positions. Gimeno (1999) adds a geographic quality to the market dimension, arguing that symmetric territorial interests will increase the intensity of the competition. Findings reported in Kwoka (1979), Kwoka and Ravenscraft (1986) also suggest that it can be very difficult to achieve and maintain recognition of the mutual dependency among members of the same strategic group, as they are constantly contesting one another's positions. It can be assumed that symmetry is negatively associated with friendly inter-firm attitudes, as competitors find themselves in conflict with one another (Easton, 1987). The following hypothesis, divided into two parts, can thus be formulated:

Hypothesis 3 A high degree of symmetry is (a) positively associated with intense competition, and (b) negatively associated with friendly inter-firm attitudes.

3.3. Climate of competition and innovative performance

As Porter (1990) points out, domestic rivalry is beneficial for a variety of reasons. The intensity of the competition increases, as information spreads fast. Strong domestic competitors generate a very obvious pressure to innovate, since local competitors tend to be the recipients of particular attention. The national press and the capital markets constantly compare one domestic competitor with another. Moreover, domestic rivals fight not only for market shares but also for skilled workers, technical breakthroughs and, more generally, for 'bragging rights'. Foreign rivals are more remote and their success can often be attributed to 'unfair' advantages. In the case of domestic rivals there are no such excuses (Sölvell et al, 1991). Psychological factors such as prestige and pride make managers and workers extremely sensitive to competitors close by (Porter, 1990). This applies especially when competitors are hostile towards each other (cf. Oesterle, 1997). If instead

competitors are friendly, the incentive to be alert and innovative disappears, which accords with Chamberlin's views on tacit collusion (Chamberlin, 1933).

In cases where competitive advantage is short-lived, firms compete intensively with one another, which puts pressure on them to improve their efficiency while also creating attractive new product offerings in the marketplace (D'Aveni, 1994). Nickell (1996) showed that firms involved in intense competition exhibit higher factor productivity, while Feldmann and Audretsch (1999) showed that firms involved in intense local competition were more innovative than other firms in monopolistic situations. A counter-argument was presented as long ago as Schumpeter's work on temporary monopoly power, where by a lower level of competition is said to favor innovative behavior (Schumpeter, 1942). We hypothesize the following relationship between climate of competition and innovative performance.

Hypothesis 4 A climate of competition featuring intense competition is positively associated with (a) product innovation, and (b) process innovation.

Hypothesis 5 A climate of competition featuring friendly inter-firm values is negatively associated with (a) product innovation, and (b) process innovation.

3.4. Cooperation within clusters and innovative performance

Relationships with surrounding firms are an essential element in theories concerned with industrial networks (Håkansson, 1982; Axelsson & Easton, 1992; Håkansson & Snehota, 1995). The main concern has been to describe the way networks are formed and how they develop over time, while less attention is paid to dynamics and innovative performance. Håkansson (1987), Lundgren (1991), Lundgren and Nyberg (1994) are notable exceptions, in that they focus more explicitly on technological development and innovation. The quality of an industrial setting is described in terms of closeness and openness between the actors within it. As a result of ongoing interactions, a firm can further intensify its cooperative situation, thus attracting resources from other firms and sharing with them the competencies and risks associated with product development (Lundgren, 1991; Bengtsson & Kock, 2000). Closeness also allows for the adaptation of products and processes, which in turn will enhance the stability of the firm's long-term relationships (Gadde & Mattsson, 1987). Product and process innovations are often the result of recurring interaction with suppliers and customers (Håkansson, 1987; von Hippel, 1988). We expect innovative performance in clusters to be positively associated with relationships in close proximity with supplying and buying firms which make high demands (Porter, 1990).

Hypothesis 6 Close and stable relationships with customers are positively associated with (a) supplier relations, (b) product innovation, and (c) process innovation.

Hypothesis 7 Close and stable relationships with suppliers are positively associated with (a) product development, and (b) process innovation.

4. The method

Data were gathered by way of a statistical sampling of all Swedish manufacturing firms. The total population was divided into five groups according to the number of employees in each firm (group 1: 5–49 employees, group 2: 50–199 employees, group 3: 200–499 employees, group 4: 500–1999 employees, group 5: >2000 employees). A sample of 50 firms in each group (except the last one which consisted of 34 companies only) was constructed, and questionnaires were sent to the top manager in the 234 selected firms. After two follow-up mails (the last one including the questionnaire), the number of respondent firms amounted to 144, or 61.5% of the total sample. The response rate differed between the five respondent groups. Firms with more than 2000 employees showed the highest response rate, 82.3%, and firms with 5–49 employees showed the lowest rate, 52.3%.

The questionnaire contained four parts. The first covered the firm's relationships within its local cluster, the second covered the industry structure in which the firm was active, the third covered climatic dimensions of competition, and the fourth described the innovative performance of the industry in which the firm was active. Thus, all measures were based on perceptual rather than objective measures. Respondents rated all the statements given in the questionnaire on a seven-point Likert scale, ranging from 'do not agree at all' to 'fully agree'. These scales were reverse-coded where appropriate, as specified in Table 1. Using the data gathered in the questionnaires, we constructed the concepts presented in our theoretical model.

4.1. Constructs and measures

Five latent variables and two manifest variables were included in the model tested in this study, and the measures of these variables will be described in that order. The wording of each survey item is given in Table 1.

4.1.1. Symmetry among competitors

Symmetry can arise in many different dimensions such as the degree of vertical integration (Newman, 1978; McGee & Thomas, 1986), the degree of product, market and geographical diversification (McGee & Thomas, 1986), and in the competitors' relative actions in different product areas (Hatten & Schendel, 1977). The list of possible dimensions is long and there is no uniformity in the treatment of strategic symmetry in empirical research (cf. Thomas & Venkatraman, 1988). However, according to Rumelt (1984) a firm's competitive strategy relates its own actions to the actions of its competitors in order to attain a stronger position, and Mintzberg (1988, 1989) defines a firm's strategic position as consisting of its market and product position. Thus, two critical dimensions of strategic symmetry include product and

Table 1
Indicators for the constructs

Indicators (the wording is the same as in the questionnaire)	Abbreviation in figure *X*	Factor loading	*T* value	R^2 value
The customer-relation construct				
Among our Swedish customers are some of the world's most sophisticated buyers when it comes to their demands on quality and/or technology	*X*1	0.61	5.11	0.38
We have been involved over a long period of time in close cooperative relationships with customers in joint developmental projects	*X*2	0.57	4.89	0.32
The supplier-relation construct				
Our firm has close personal contacts with our most important suppliers	*X*7	0.51	5.35	0.26
Our firm and our suppliers have invested in production and distribution systems in order to adjust to each other	*X*8	0.98	6.50	0.97
The symmetry construct				
Your company and your main competitors are operating in the same product niches (reversed)	*X*5	0.88	11.42	0.77
Your company and your main competitors' product lines are similar MARKET	*X*6	0.71	8.98	0.51
The intensity-in-competition construct				
The rivalry among competitors is very strong	*X*3	0.68	8.34	0.46
The competition for increased market shares is very strong (reversed)	*X*4	0.99	7.55	0.99
The friendly relationship construct				
Your company and your main competitors look upon each other as colleagues who develop markets and/or products side by side	*X*9	0.58	5.76	0.34
Your company ant its main competitors are often supportive of each other	*X*10	0.75	6.14	0.56

market symmetry (cf. also Chen, 1996). Besides customer segment, the market dimension also includes the geographical reach (cf. McGee & Thomas, 1986; Gimeno, 1999) Hence, survey items measure the symmetry among competitors with respect to their products (X_1) and to their markets (X_2).

4.1.2. Intensity in competition

We have defined intense competition in terms of frequent moves and counter-moves, and have measured intensity by asking respondents how they perceive the strength of the rivalry between their own firm and its competitors (X_3). Intense competition can have recourse to a variety of means. Harari (1999) describes dog-eat-dog competition as competition through price-cuts, but price competition does not stimulate innovative behavior (cf. Danzon, 1997). Rather, innovative performance is stimulated by the moves and counter-moves of competitors in the market (new entry, new information offerings, improved delivery and customer care) (cf. Shaanan & Feinberg, 1995; Harari, 1999). It can thus be assumed that competition for market positions inspires firms to be innovative (X_4).

4.1.3. Inter-firm attitudes

To measure the inter-firm attitudes that develop in relationships between competitors, we have used the distinction between hostile and friendly climates of competition (Oesterle, 1997), and the distinction between attitudes towards each other and attitudes towards the interaction that occurs among competitors (Bengtsson, 1998). Survey items measure (1) the relevant values among the other competing firms, which are then described as enemies or colleagues (X_5), and (2) values revealing the type of interaction between competitors, which is then described as hostile or supportive (X_6).

4.1.4. Customer relations

It is argued that closeness in relationships with customers and with other actors in a particular environment is of crucial importance to local innovative processes. Such closeness makes it easier to communicate and combine ideas that are of importance to creative processes. Håkansson (1987) suggests that not only close contracts but also persistent ones are important to the creation of tight relationships in a network. We argue here that closeness to customers is not the only factor that affects a firm's innovative performance. In order to introduce a value dimension to the 'customer relation' construct, it is important to take account of the strength of the customers' demands. Our survey items measure the quality of a customer relationship in terms of the degree of closeness and stability (X_7), and of the advanced nature of the customers demands (X_8).

4.1.5. Supplier relation

Closeness is also important in relationships with suppliers, in order to create a dynamic and creative interaction that stimulates innovative performance. Closeness can be measured on a personal level (X_9) and a functional level. A firm can also have a close relationship with a supplier expressed in the adjustments it makes to the

production and distribution system to conform to the needs of the supplier in question (X_{10}).

Pearson's correlation analysis was performed to provide a rationale for the latent variable constructs used in our model. All the latent variables exhibited high reliability (symmetry 0.525, $p<1$, intensity in competition 0.600, $p<1$, inter-firm attitudes 0.467, $p<1$, customer relationships 0.284, $p<1$, and supplier relationships 0.393, $p<1$). The latent variables are also strong in the LISREL analysis.

4.1.6. Product and process innovation

The two performance variables used in our model, namely product and process development (see e.g. Utterback & Abernathy, 1975) are manifest. The first variable refers to technological exploration and the introduction of new products, and the second to increased efficiency through incremental process innovations (see the discussion of the difference between exploring and exploiting activities in March, 1991). Two survey items were constructed to measure product and process innovation. The first measures whether the technical construction of the product has been fundamentally changed in recent years (Y_1), while the second measures whether efficiency has been extensively improved in the same period (Y_2).

4.2. A structural equation model analysis

A complex phenomenon such as localized innovative processes can be explained by a multivariate setting of factors, which means that several inter-related perceptual variables need to be included and tested simultaneously. A structural equation model is therefore a more appropriate tool than regression analysis for exploring the way various industrial settings impact innovative performance within industries. In regression analysis, it is only possible to determine the relationship between separate dependent and independent variables, whereas simultaneous estimations of reciprocal inter-dependent causation are possible in a structural equation model analysis. This last is thus useful for analysing perceptual rather than experimental data (Bagozzi, 1977).

A variety of structural equation models are available, and in the present study a LISREL model was chosen. LISREL is suitable for testing models posited a priori as containing measurement errors and reciprocal causation (Bollen, 1989). A LISREL model consists of both the measurement model, and the structural equation model. The structural equation model subsumes regression, variance and path analyses (Jöreskog & Sörbom, 1986). The model shown in Fig. 2 details the variables and pathways corresponding to the hypotheses specified above.

Two of the variables that describe competition in specific local environments are regarded as endogenous variables in the model, as the variability is determined by the exogenous variable in the model. It is assumed that the exogenous and the endogenous variables both have a direct effect on the degree of product and process development. Symmetry, the exogenous driver of the climate of competition is also assumed to affect innovative performance indirectly via the endogenous variables. It

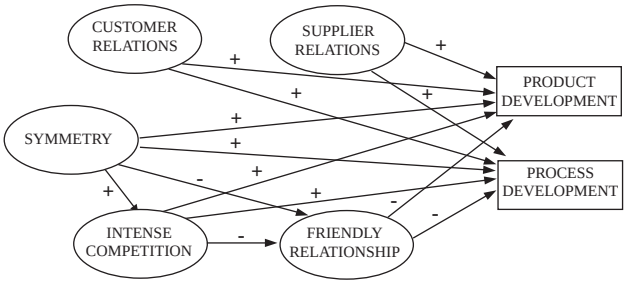

Fig. 2. Proposed model of variables that describe competition and cooperation in local industrial settings and their effect on innovative performance.

is also assumed that customer relationships impact innovative performance directly and indirectly via the supplier relationships.

5. Findings

The proposed theoretical model tested the overall fit of the model and the fit of each suggested pathway with the help of LISREL VII. It was shown that the overall fit was poor, as the chi-square (χ^2) for the model was only 67.48, $p = 0.0023$ (38 d.f.). However, the Goodness of Fit Index was 0.93 and the Adjusted Goodness of Fit Index was 0.86, which is regarded as acceptable. In view of the poor chi-square value, we decided to modify the model in accordance with the modification indices.

The modification indices suggested that a path between intensity in competition and relationship with supplier, which was not specified in the theoretical model, should now be included in order to improve the fit. According to the altered model the inter-relatedness between different drivers in the local environment is relevant, since different parts of a particular local industrial setting are integrated with one another. A firm's close relationship with suppliers through its adjustments and adaptations to the supplier might reduce the ability to exit the market due to sunk costs (Gilbert, 1989). This suggests that firms have to compete intensively to retain and continue to develop their market position, which in turn gives rise to intense competition.

The model that emerged after the above modification is presented in Fig. 3 (only supported relationships are specified). All the parameter estimations are presented in Table 2. The chi-square (χ^2) for the modified model is 49.90, $p = 0.076$ (37 d.f.). The modifications introduced also improved the Goodness of Fit Index (0.95) and the Adjusted Goodness of Fit Index (0.89), which is regarded as very good. Other fit statistics also suggest a good fit. The normed fit index recommended by Gerbing and Anderson (1992) is 0.90, the non-normed fit index is 0.95, the comparative fit index 0.97 and the rout mean square residual 0.056, all of which are well within acceptable ranges. The adjusted model thus accounts for a substantial amount of variance. The

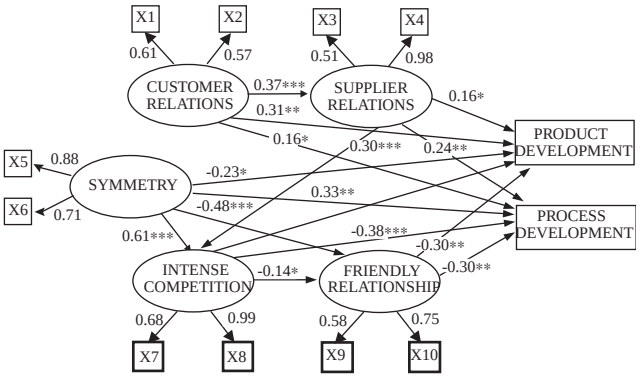

Fig. 3. Structural path estimates of the hypothesized model (*$p<0.10$, **$p<0.05$, ***$p<0.01$).

Table 2
Parameter estimates for the modified structural model

Description			Unstand.	*t*-value
Symmetry	→ (+)	Product development	−0.23	−1.38*
Symmetry	→ (+)	Process development	0.33	1.94**
Intense competition	→ (−)	Friendly relationship	−0.14	−1.41*
Symmetry	→ (+)	Intense competition	0.61	4.57***
Symmetry	→ (−)	Friendly relationship	−0.48	−3.60***
Intense competition	→ (+)	Product development	−0.19	−1.02
Intense competition	→ (+)	Process development	−0.38	−2.50***
Friendly relationship	→ (−)	Product development	−0.30	−2.38**
Friendly relationship	→ (−)	Process development	−0.30	−2.40**
Customer relation	→ (+)	Supplier relation	0.37	2.77***
Customer relation	→ (+)	Product development	0.31	2.36**
Customer relation	→ (+)	Process development	0.16	1.31*
Supplier relation	→ (+)	Intense competition	0.30	3.45***
Supplier relation	→ (+)	Product development	0.16	1.36*
Supplier relation	→ (+)	Process development	0.24	2.02**

correlation matrix to be analyzed in order to test the model is presented in Table 3 and the model that emerged is presented in Fig. 3.

We generally obtained good results. Fourteen out of 15 paths in the model were supported or strongly supported, however, two with the opposite sign (see Table 2). The only path not supported in the model, somewhat surprisingly, was the path between intense competition and product innovation, a point, which will be discussed further in the next section. Apart from that, our findings suggest that symmetry is negative for product development, against our expectation, and positive for process development as we suggested. Hypotheses 2 and 3 defined the internal relationships within a climate of competition and the way structural conditions affect the climate. The analysis supported Hypothesis 2 that a high degree of intensity in

Table 3
Correlation matrix to be analyzed

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	Y1	Y2
X1	1.00											
X2	0.36	1.00										
X3	0.17	0.08	1.00									
X4	0.18	0.24	0.50	1.00								
X5	−0.12	−0.04	−0.12	−0.03	1.00							
X6	−0.25	−0.15	−0.11	−0.14	0.62	1.00						
X7	−0.10	−0.08	−0.07	0.06	0.44	0.28	1.00					
X8	0.02	−0.04	0.12	0.24	0.58	0.42	0.68	1.00				
X9	−0.18	−0.02	0.08	0.08	−0.24	−0.08	−0.27	−0.25	1.00			
X10	0.02	−0.02	−0.05	−0.01	−0.36	−0.18	−0.26	−0.32	0.44	1.00		
Y1	0.30	0.21	0.07	0.24	−0.22	−0.33	−0.14	−0.06	−0.10	−0.02	1.00	
Y2	0.00	0.11	−0.07	0.14	0.19	0.08	0.19	0.03	−0.12	−0.25	0.15	1.00

competition is negatively associated with friendly inter-firm attitudes. Hypothesis 3 is the most strongly supported of all the hypotheses. Intense competition occurs when the competitors are symmetric, i.e. operating within the same product and market segment. Furthermore, in symmetric settings competitors develop hostile attitudes towards one another and towards the way the other competitors act.

Hypotheses 4 and 5 define the relationships between the climate of competition in the local environment and innovative performance. Intense competition is not related to product development, as we have already mentioned, but is strongly related to process development. Intense competition is negatively related to process development, however, against our expectation. A possible explanation for the results diverging from those hypothesized above could be that our construct 'intense competition' was created on a basis of the competitors overall perception of the high intensity of the competition, and that the competition for market position is intense. The construct might thus be geared primarily to intense static competition, in which firms focus mainly on price competition. The incentive to develop radical product innovations or to improve internal efficiency may then be less important to firms in such a situation. In the case of both product and process innovation a hostile climate of competition is positive, while a helpful climate is negative. Moreover, these relationships between inter-firm attitudes and innovative performance are strongly supported.

Hypotheses 6 and 7 define cluster characteristics and the way they impact innovative performance. Our assumption that the relationships with different actors in the environment are related to each other is strongly supported. Relations with customers and suppliers seem to make an asymmetric impact on the innovative performance of the firms. Relations with customers are related more strongly to product development, while the relations with suppliers are related more strongly to process development, although both types of relationship are of some importance for both types of innovative performances.

6. Discussion

In this article we have developed a rich model of competition (including structural and relational dimensions) and of cooperation in local industrial settings. We have also used the model to explain innovative behavior connected with both product and process development. The nature of competition is described along one structural characteristic—symmetry among actors—and two climatic dimensions—intensity in competition and degree of friendliness/hostility. Symmetry clearly drives the degree of hostility, both directly and indirectly, via the degree of intensity in the competition.

From the analysis it is possible to distinguish two types of competitive climate. The first can be described as a 'hot' climate. Symmetry generates a climate of competition in which inter-firm attitudes are hostile, and competition is intense. However, a drawback of the construct is that the link between competition intensity and hostile attitudes is weak and significant only at a 0.1 level of significance. The second type of climate is the opposite of the hot kind and can therefore be described as a 'cold' climate. Asymmetric firms do not compete intensively with each other and can develop friendly attitudes towards each other, directly because of the asymmetry and indirectly because of the low intensity of the competition. The hot climate stimulates product and process development, while the cold one works in the opposite direction.

Asymmetry among competitors is traditionally said to give firms an opportunity to develop monopoly power by dividing the market among themselves, which in turn reduces the intensity of the competition (Chamberlin, 1933); instead the firms coexist (Easton & Araujo, 1992). However, asymmetry does not necessarily imply that firms coexist without any interaction: asymmetric firms may interact with each other although they are not competing in the same market or product segments.

Further, our model provided strong support for the claim that climatic dimensions do impact innovative performance within industries, thus adding explanatory power. This is consistent with earlier models based on industry recipes (Spender, 1989), industrial wisdom (Melander, 1997), and industry mental models (Porac et al., 1995), which focus on perceptions and attitudes within industries as drivers of firm behavior. On the other hand, we found no link at all between intensity in competition and product development, and only a negative link with process development. This could be explained by the counter-argument mentioned earlier, namely that only firms expecting temporary monopoly power (Schumpeter, 1942) invest in risky development projects (this is of course the rationale behind the patent system).

Symmetry drives process development, while the link between symmetry and product development proved to be significant but with the opposite sign. One possible explanation for this is that the diversity provided by asymmetry can lead to creative combinations of dispersed ideas and resources (Porter, 1990). Firms being exposed to different market environments create new and diverse ideas originating from different market niches (Hitt, Hoskisson, & Kim, 1997). And as symmetrical industries are associated with mature stages in the product cycle (cf. Utterback &

Abernathy, 1975), symmetry can be expected to be positively associated with process development but to have less connection with product development.

Besides explaining innovative performance by reference to different competitive settings, we also introduced the role of cooperative relationships with customers and suppliers within clusters. In line with the literature on networks (Håkansson, 1987) and supplier–customer interaction (von Hippel, 1988), we argue that innovation in both product and process development is enhanced by way of vertical cooperation. As expected, process development is related more to supplier interaction, and product development more to customer interaction. One question for further research is whether, and if so how, the atmosphere or climate that develops as a result of interaction with customers and suppliers, affects the innovative performance of firms. This is consistent with the finding that actions in networks are critically dependent on the behavioral and cognitive aspects of interactions that are built up between firms over time (Dahlqvist, 1998).

In sum, this article has shown, first that the nature of the competition within an industry can be captured by reference to the climate of competition, which can range between the hot and the cold and, second, that such climate is complement to certain structural characteristics of competition. The climate of competition acts as an intervening variable between structural conditions and the innovation process. In addition, the article shows the importance of cooperation within clusters as a driving mechanism behind innovation.

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