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LINKAGE LOCK-IN AND REGIONAL ECONOMIC DEVELOPMENT: THE CASE OF THE ØRESUND MEDI-TECH PLASTIC INDUSTRY

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Abstract

This paper investigates barriers to the process of regional economic development from a linkage perspective. It develops the concepts of linkage lock-in and switching costs as fundamental factors explaining some of the social dynamics of the process. The overall claim of the paper is that different types of costs and their determinants may lock firms in to existing linkages, creating a probable barrier to successful regional economic development. The paper defines linkage lock-in as the difficulty in switching to alternative linkage partners, even if this is desirable. Switching costs are the costs involved in terminating and forming linkages. The extent of transaction costs, dynamic transaction costs and opportunity costs delineate switching costs in interfirm linkages. The paper further elaborates on the concept of opportunity costs; it states that in dynamically competitive environments a class of opportunity costs, namely *learning opportunity costs* might arise as a result of the relative importance of learning and innovation. Learning opportunity costs are defined as the costs of missing key possibilities to learn in dynamically competitive environments. They are furthermore seen as being constituted by cognitive costs, which in turn are influenced by the existence of information costs. The theoretical argument is illustrated by a case study of the medical part of the Øresund medi-tech plastic industry.

Key words: Regional economic development; interfirm linkages and switching costs; lock-in and learning; cross-border business; medi-tech plastic industry.

JEL classifications: D83, L14, L22, L68, R58

1. Introduction

In most OECD countries today regional economic development has become essential for policy makers. The main reason is that with globalization, regions are seen as “increasingly important sources of innovation and economic growth” (Florida 1995, p. 528). In this respect, the notions of *the learning economy* (Lundvall and Johnson 1994, Lundvall and Archibugi 2001) and *the learning region* (Florida 1995, Morgan 1997) bear the promises for firms, regions, and nations alike to achieve sustained competitive advantage in an ever more globalized economy. Such notions are based on the view that for economic development, knowledge is the most important asset – and hence knowledge production the most fundamental process. With this conceptualization, the learning capacity of any economic system, and hence interregional differences in learning capacity, become of strategic significance (Maskell *et al.* 1998).

Regional learning capacity rests fundamentally on the organization of production and innovation, and is essentially an outcome of localized learning (Asheim and Cooke 1999, Hudson *et al.* 1997). To such organization, interfirm linkages and effective knowledge reallocation are becoming increasingly important (Lundvall and Johnson 1994). Learning regions are thus described as organized around co-dependent linkages and firm constellations (Florida 1995), and they are characterized by collective learning through such linkages (Morgan 1997).¹

Linkages and their positive effects on regional economic development have been treated as given and unproblematic in this stream of literature. The potential disadvantages of linkages have been left largely unexplored (for a notable exception, see Maskell 2001b). One reason may be that in general, such potential disadvantages are understood as firm level concerns, and therefore beyond the scope of research into regional economic issues. Recently, however, some economic geographers have begun to theorize matters of the firm – including the endogenous mechanisms that influence the firm’s mode of external interaction – with the stated purpose of advancing our understanding of regional issues (Maskell 2001a, Taylor and Asheim 2001).

These are important endeavors, since the dynamics of linkages determine their outcome, and therefore also their influences on the wider environment in which they are embedded. Of particular importance in this context is the appreciation that promoting interfirm linkages in regional economic policy is not a panacea for regional economic success. We need at least to understand what the limitations and pitfalls of participation in linkages are, and how these might in effect work against successful regional economic development.

This paper takes an initial step towards addressing this issue. Accepting that the efficiency of interfirm linkages is positively correlated with regional development (although the benefit effects may differ among regions), we argue first that linkage participation may potentially also lead to linkage lock-in (defined here as the intricacy in switching to alternative linkage partners, when switching is thus desirable). When the environment changes (e.g., because of a new innovation), firms might need to switch partners to gain access to new complementary assets, and to be innovative. Deciding not to switch, when switching is in fact desirable would jeopardize a firm. For example, in his study of the adoption of a major innovation in the computer industry – RISC (reduced instruction set computer) technology – Afuah (2000) found that strong linkages might lock a firm in to existing technologies, thereby potentially

disadvantaging it in a changing environment.

We argue that transaction costs (Williamson 1975), dynamic transaction costs (Langlois 1992), and opportunity costs (Sanchez *et al.* 1993) play crucial roles in determining overall switching costs. Moreover, in dynamically competitive industries, the relative importance of learning may lead to a certain class of opportunity costs caused by linkage lock-in, namely *learning opportunity costs* (defined here as the costs of missing some key possibilities to learn in such an environment).

Second, we wish to establish a possible role of linkage lock-in in influencing the dynamics of regional development. Accepting the claim that the pattern of interfirm linkages are part of the dynamics of regional development, the central thesis of the paper is that different types of costs and their determinants may lock firms in to existing linkages (i.e., prevent them from switching partners), and that such lock-in may indeed be an obstacle to successful regional development.

This thesis is illustrated empirically with the case of a Swedish firm operating in the Øresund medi-tech plastic industry. In this industry, which is also a main part of the biomedical system in Sweden (Braunerhjelm *et al.* 2000, Stankiewicz 1997), participation in linkages is the norm rather than the exception (Hansen and Serin 1989). The Øresund area is chosen because it – despite high initial expectations of integration and the development of a coherent learning region – still has not experienced an increase in the kind of cross-border linkages that might be necessary for gaining regional competitive advantage. Danish firms seem to keep on seeking linkage partners on the Danish side of the area, and Swedish firm tend to limit their attention to the Swedish side.

The fact that Øresund is a cross-border area provides a welcome opportunity to explore switching costs as a potential economic rationale for firms on both sides of the sound to continue well-established linkage practices, and thus as a barrier for further regional development. The cross-border dimension is treated as a special case of regional economic development, a dimension that may be highly relevant in this context. To be sure, Sternberg (1998) has articulated the need for research focusing on interregional (or cross-border) differences and the importance and consequences of interfirm linkages. In the present case, institutional differences (e.g., differences in language, customs, trade regulations and business practices) might increase switching costs. Even if potential cross-border partners operate in the same line of activity, such differences likely daunt them from forming a linkage, simply because they may have a hard time understanding each other properly.

The remainder of the paper falls in five parts. In section two, the theoretical argument is presented through an elaboration on the concepts of linkage lock-in and switching costs. In section three we discuss learning opportunity costs and their determinants more thoroughly. In the fourth and fifth sections, linkage lock-in and switching costs in Øresund are investigated through a case study of a Swedish medi-tech plastic company and its supplier linkages. The final section presents some concluding remarks and suggestions for further research.

2. Lock-in and switching costs in interfirm linkages

2.1 *Linkages and learning*

To make the term as neutral and dynamic as possible, we will refer to interfirm linkages as (formal or informal) relations between two or more firms formed in order to transfer, exchange, develop or produce resources or products. By avoiding the inference that partners are necessarily working towards mutually shared goals, this definition may overcome some of the limitations (e.g., embedded assumptions) of labels like strategic alliances, collaborative agreements, and interfirm cooperation (Auster 1994).

Linkages can be important sources of competitive advantage for a firm. Through linkages a firm might get access to the complementary resources necessary to compete in current and future markets (Hagedoorn 1993), while at the same time remaining flexible (Jarillo 1988). Linkages may furthermore provide the interacting firms the opportunity to learn, either from each other or jointly (Doz 1996, Hamel 1991, Mowery *et al.* 1996, Powell *et al.* 1996). Especially in dynamically competitive environments (Grant 1996a), where the knowledge base of an industry is both complex, dispersed and expanding, innovative firms might thus form linkages with other firms to create and take advantage of learning opportunities, and to share the costs of using and producing knowledge (Powel *et al.* 1996).² The computer, semiconductor and the biotechnology industries illustrate the notion of dynamically competitive environments (Malerba and Orsenigo 1996). For instance, in the sense that product innovation in the computer industry often depends on the combined efforts of different multi-product and specialized firms (integrating complex architectures, advanced systems software, semiconductor components, disk drives, terminals and floppy disks), a dynamically competitive environment characterizes this industry.

Specialization is one of the main advantages of linkages, as all activities cannot be integrated into one firm. Complex networks of cooperation emerge “because of the need to coordinate closely complementary but dissimilar activities” (Richardson 1972, p. 892). Advantages center around obtaining internal scales economies, innovation, and learning through interaction with other firms. Despite these generally optimistic views on interfirm linkages there might be downsides to cooperation as well, often overlooked in the literature.

The behavior of one party may enhance the interests of the other party, on the one hand creating a stronger linkage, but on the other hand also raising the potential costs of switching partners (Jackson 1985, p. 126). Participation in linkages does more than simply compensate for the lack of internally developed competencies, and they involve much more than a series of discrete transactions (Powell *et al.* 1996). To make a linkage efficient, the partners must adjust and develop their routines and capabilities, as well as a supporting institutional framework (e.g., trust), in a way that is specific to the linkage. This means that the firms have to invest in the linkage, and this is likely to create tight limitations on the flexibility of their future actions. When terminating the linkage, these investments generally cannot be recaptured (Maskell 2001b).

2.2 *Lock-in and switching costs*

In an industry environment where the knowledge base is complex and expanding and the knowledge widely dispersed, interfirm linkages provide access to knowledge and tangible resources that cannot be generated internally (Nelson 1990). Therefore, interfirm linkages serve as a locus of innovation, and participation in linkages is thus necessary for a firm to be continuously competitive in such an environment. However, as Afuah (2000) demonstrated strong interfirm linkages might lock a firm into existing technologies, thereby potentially disadvantaging it in a dynamically competitive environment. If a firm has come to depend strongly on the capabilities of its partners, external change that makes the partners' capabilities obsolete can have dire results for the firm, even if the change does not impact directly on its own capabilities.

This leaves the firm with the difficult choice of whether to stay with current partners or switch to new partners, whose capabilities have not been rendered obsolete by external change. The choice is arduous inasmuch as switching partners – besides the difficulties in finding alternative partners – implies having to build new linkages. In such a choice situation, the firm is restrained by the routines and capabilities it has developed in its previous and current linkages.

Substituting partners involves compound decisions about the termination and initiation of linkages, and therefore switching costs (that is, the costs involved in terminating a linkage and forming a new one) are closely connected to participation in interfirm linkages. Furthermore, terminating and forming linkages are interdependent, and therefore complex processes.

Jackson (1985) applied the concept of switching costs to buyer-supplier linkages, suggesting that switching costs consist of the tangible and intangible costs a customer faces in changing suppliers. The amount paid for products and services provided by an existing supplier, relative to the amount spent with an alternative supplier, are likely the only types of switching costs that can be measured fairly objectively.³ However, they are also likely to be the least important switching costs. Other types of investments may bring on more significant switching costs. For example, past investments in operating procedures are likely to create structural inertia and resistance to switch suppliers.

In the following, we elaborate on the concept of switching costs as being constituted by incentive related costs, dynamic transaction costs, and opportunity costs. With regards to the concept of opportunity costs we argue that in dynamically competitive industries a class of opportunity costs (learning opportunity costs) might arise as a result of the relative importance of learning.

The advantages of interfirm learning influences the elaboration on the concept of switching costs as applied in this paper. The reason is that, although linkages might provide an opportunity for ongoing access to resources and capabilities, and despite the fact that new knowledge is often created within linkages through processes of interfirm learning, specialized companies might still need occasionally to switch suppliers to gain access to new complementary capabilities and to be innovative. To successfully adapt to the pressures of a changing business environment, firms must obtain timely access to complementary assets and activities on competitive terms, especially in dynamically competitive environments (Teece 1986). They might need to be able to quickly find new partners and cooperate at low

switching costs (i.e., they may need to coordinate the new information flows necessary for innovation in a manner that minimizes costs). In other words, efficient linkage participation is dynamic.

Firms might be reluctant to switch partners either because of the short-term risks involved (i.e., the risks that new suppliers cannot live up to expected or required performance standards), or because of the constraints imposed by credible commitments. In the longer run, however, the risks of not switching might far exceed short-term risks. Fear of short-term risks might impede a firm's willingness or ability to adapt to changes or take advantage of productive opportunities, and it might give competitors the time to make successful and preemptive moves (Jackson 1985).

The existence of linkage specific competence that might result from durable investments in the complementary assets of partners – and the difficulty of knowledge transfer in general – imply that it will be costly to switch to an alternative supplier (Teece 1980). Thus, switching costs measure the extent of one firm's lock-in to its existing partners, and they apply both ways in a linkage (Shapiro and Varian 1999). In the following, the difficulties of switching partners are elaborated in terms of possible classes of switching costs.

2.3 Classes of switching costs

From an organizational economics perspective, switching costs in linkages are seen as the *incentive related costs* associated with changing partners. When a contract between two firms is concluded, durable linkage specific investments in human and physical assets will lock the firms into a bilateral monopoly situation – illustrated by the notion of the fundamental transformation (Williamson 1975, 1985). Terminating such an existing linkage would sacrifice economic value. Except when the investments made are transferable to alternative uses (e.g., linkages with other firms) at low cost, the economic benefits can be realized only by maintaining the linkage. The costs that arise are seen as incentive related in the sense that linkage lock-in, combined with transaction costs more generally, increases the risk of opportunistic behavior on behalf of the partner firm, and therefore creates problems of safeguarding. Eventually, linkage lock-in will replace autonomous trading conditions ex-ante with unified ownership (Williamson 1985).

Also *dynamic transaction costs* – defined here as the costs of having to reallocate certain capabilities, or losing certain capabilities in existing interfirm linkages, as a result of external pressures and economic change (Langlois 1992, Langlois and Robertson 1995) – are important as regards switching to new suppliers. Generally, dynamic transaction costs work in favor of vertical integration, since economic change might raise the dynamic transaction costs of “informing and persuading new in-put holders with necessary capabilities” (Langlois and Robertson 1995, p. 3). In a situation where the market cannot provide the right complementary assets at the right time, an efficient firm will, all else equal, choose to integrate. For example, it may prove far more costly to inform and persuade other firms with the necessary complementary assets to engage in a linkage than to vertically integrate into the necessary complementary activities (Langlois 1992).

Conversely, when the firm itself cannot acquire or develop the right complementary assets at the right time, specialization might be the most efficient choice. However, dynamic transaction costs are themselves influenced by the availability and configuration

of *external* complementary assets, as also recognized in the various studies on industrial districts. Whether the firm should develop new capabilities to compete in dynamically competitive environments through the market, internally within the firm, or through participation in linkages depends on the present structure of capabilities, and on the nature of the economic change involved.

Opportunity cost might also be important when considering switching partners. From a strategic-options perspective, it is inefficient for a firm to use its limited resources to strongly commit to its current suppliers in order to get access to assets (or to internalize these), which it could easily obtain from other sources in the future (Sanchez 1993). The implicit opportunity costs of either vertically integrating or staying with current suppliers are the costs of forgoing options on future opportunities from engaging early on with new suppliers. A strategic-options perspective emphasizes such costs when a firm uses its limited resources to either stay with a current supplier or to internalize resources and capabilities now.

3. Learning opportunity costs

To take the analysis to a deeper level, we claim that in industries where productive knowledge is relative more distributed and learning highly complex, it is essential to find out what are the costs of forgoing opportunities explicitly related to learning, what we call *learning opportunity costs*.

Inspired by the notion of dynamic transaction costs, we argue that additional opportunity costs can be found in the costs of losing opportunities to learn when switching suppliers, costs that may apply to the situations of both terminating existing linkages and forming a new linkage. We furthermore argue that these costs are constituted by cognitive costs (i.e., costs that might arise as the result of an inability of the interacting parties to understand each other and the knowledge to be transferred, when creating new linkages) and by information costs (i.e., latent costs arising from a lack of knowledge about potential partners in other geographical areas or industries). Especially, information costs magnify learning opportunity costs in a cross-border context and thus influence overall switching costs.

As regards the termination of an existing linkage, learning opportunity costs might arise from not exploiting further the experience benefits that come from long-term commitment. In this respect, learning opportunity costs are closely related to dynamic transaction costs in the sense that the enclosure of an activity within a firm is influenced by the learning opportunities associated with that specific activity. With respect to initiating a new linkage, learning opportunity costs potentially arise, as the firm engaging with a new partner might not be able to understand and communicate with this partner in the way it did with former partners. Learning opportunity costs, then, turn a firm from switching partners.⁴ The risk that a firm might be unable to effectively process information or utilize knowledge in new linkages leads to high cognitive costs, which will temporarily inhibit interfirm learning in the new linkage and increase learning opportunity costs. In the following, we discuss determinants of learning opportunity costs more carefully.

3.1 Determinants of learning opportunity costs

Cognitive costs

Much knowledge is firm specific and idiosyncratic, that is, compared to tangible resources it is often difficult to trade knowledge on strategic factor markets (Dosi *et al.* 1990). Because of the firm specific and idiosyncratic nature of much knowledge, knowledge transfer might suffer from cognitive costs (Jensen and Meckling 1997). Of course, a certain level of cognitive differences might be necessary for learning to take place in the first place. If two firms in a linkage are almost identical, there is a limit to how much they can contribute with new resources and capabilities.

The cognitive costs of transferring knowledge depend on factors such as the nature of the knowledge involved, the information channels through which knowledge is conveyed, the sender and the receiver of knowledge, and the external environment (Jensen and Meckling 1997, Husman 2001). In the following discussion, we will distinguish between (1) the institutional aspects of the linkage and (2) the broader institutional environment, as constituting analytically singular aspects of the external environment.

- (1) *The nature of the knowledge*: knowledge, being explicit or tacit, might generate cognitive costs, as especially tacit knowledge is difficult to transfer. Moreover, the sender and the receiver are likely to differ in terms of cultures and codebooks (i.e., lingo and communicating patterns within a firm) for processing information and interpreting knowledge, contributing to an increase in cognitive costs.
- (2) *The knowledge channel*: the channel through which knowledge is exchanged might be a source of costs. Cognitive costs arise if the knowledge sender or receiver does not fully comprehend the sharing mechanisms used (i.e., memos and instructions vs. face-to-face interaction). However, the cognitive costs associated with a sharing mechanism also depend on the nature of the knowledge involved. A good match between the sharing mechanism and the nature of the knowledge can confine cognitive costs, for example, by using face-to-face interviews in a situation where the knowledge to be transferred is highly tacit.
- (3) *The knowledge sender and receiver*: the organizational structure of a knowledge sending or receiving firm influences a firm's absorptive and communicative capacity (Cohen and Levinthal 1990). For example, cognitive costs arise if the relevant knowledge has to pass many sub-units, or if at least one of the firms is characterized by a high degree of inertia. Additionally, the frequency and experience with interaction affect the costs arising in a knowledge transfer situation. The more frequent the interaction, the more intimacy is likely to be developed and a body of common knowledge is established, decreasing cognitive costs.⁵
- (4) *The institutional aspects of the linkage*: the more experienced the sender and the receiver are with knowledge transfer in a specific linkage, the lower are also the cognitive costs, as the interacting parties' knowledge transfer capabilities are to be expected to converge in important ways.

In conclusion, cognitive costs are likely to arise when firms switch suppliers, as new suppliers do not have the same experience, the same knowledge base and the same culture. This might have the effect that knowledge will not be created and used as efficiently in a new linkage, potentially leading to high learning opportunity costs attributable to lost opportunities for valuable learning. As mentioned above, a certain level of cognitive differences might be necessary for learning to take place in the first place. The key is therefore to find a balance where linkage participation and interfirm learning are not impeded by cognitive costs, and where at the same time the interacting parties can contribute significantly with new resources and capabilities.

Information costs

There might be certain information barriers when a firm seeks to find and engage in new linkages. A lack of information about the possibilities for interacting with new partners from, say, other locations or industries might lead a firm to form linkages with firms from their own restricted area or industry; not because they are the best or most well-suited partners, but simply because they are the only ones the firm knows about. Hence, a lack of information is a tremendous barrier in terms of learning opportunity costs (and thus also the overall concept of switching costs in interfirm linkages), as some linkages might never be realized, even if they could potentially lead to competitive advantage. In other words, high information costs magnify the problem of learning opportunity costs, as they might hinder opportunities for learning. If a firm does not learn from its current supplier linkages but has no information about other suppliers, it is inclined to stay with the current supplier. Consequently, from a lack of information about other possibilities a firm can miss out on key opportunities for learning by staying in a current linkage.⁶

The role of the broader institutional environment for cognitive and information costs

Mowery *et al.* (1996) argue that especially distance and cultural difference between firms in a linkage might impede successful knowledge transfer. Such differences might owe both to spatial and organizational distance. By increasing the likelihood of interfirm interaction, spatial proximity might facilitate the organizational proximity necessary for creating innovations and resources through collective learning (Hudson 1999). Conversely, when interfirm linkages are set in a cross-border context (understood here as a context comprising different national innovation systems), learning opportunity costs might increase, because cognitive costs are likely to increase and because information costs might be higher (Lundvall 1992). This might prevent firms from engaging in the kind of linkages, which are essential for successful regional economic development.

National innovation systems can be conceptualized as encompassing all institutions and organizations directly involved in search and exploration activities (R&D departments, technological institutes and universities), but also the different parts of the economic structure and the institutional set-up affecting exploration and learning (Johnson 1992). Institutions are also the sets of habits, routines, rules, norms, and laws that regulate the relations between people and shape human interaction (Coriat and Weinstein 2002, Johnson 1992). Thus, the institutional endowment of a delimited geographical area should

be defined broadly, embracing all the rules, routines, and norms associated with geographically delimited factor and product markets as well as the entrepreneurial spirit, moral beliefs, political traditions, decision-making practices and other basic values characterizing a given area, region, or country (Maskell and Malmberg 1999).

Consequently, firms that want to cooperate across borders might face higher cognitive costs and thus higher learning opportunity costs, as common ground does not fully exist. That is, even though the interacting parties are in the same industry, institutional differences might affect the formation of linkages. Differences in language, customs and traditions might disturb communication and knowledge transfer between partners of different countries of origin (Peterson and Schwind 1977). Owing to such differences, interacting firms might have a hard time understanding each other properly. This might lead to lost opportunities for learning *ex post* and thus potentially create learning opportunity costs. However, also the more practical aspects of linkage participation can affect the costs of interacting, as common trade regulations and common business practices might not readily exist.⁷

Lacking information about the possibilities for participation in cross-border linkages increases information costs, with the result that firms participate in linkages with firms from their own national system of innovation. Hence, a lack of information constitutes a barrier for cross-border regional development. Therefore, successful regional development in a cross-border context may be inhibited by high switching costs.

Summing up, when switching suppliers one should not only consider transaction costs, dynamic transaction costs, or opportunity costs, but also learning opportunity costs and their determinants, as these might magnify or inhibit switching costs in some industries – even if transaction costs are low. Moreover, when interfirm linkages are set in a cross-border area, it is argued that differences in national innovation systems might increase the cognitive costs as well as the information costs, increasing overall switching costs.

However, different costs might appear with different importance in different industries. Different industry structures and the external environment determine which costs dominate in a certain situation. Sometimes the structure of a given industry and its environment might result in a disposition for high incentive related costs, whereas in other instances there might be a tendency to high learning opportunity costs, owing to the economic importance in these situations of producing knowledge relative to using existing knowledge. Determining more precisely the characteristics of an industry and its environment, under which the one or the other situation will win through, might prove an important area of future research.

4. A case study of linkage lock-in and regional economic development

To illustrate the theoretical line of argument outlined above we now direct attention towards the Øresund medi-tech plastic industry. By analyzing cognitive costs, information costs, and the influence of cross-border differences on these, we wish to determine the level of linkage lock-in and switching costs in the industry and how they impact on processes aiming at cross-border regional development in the area.

4.1 Data collection

The following empirical example is drawn from a larger research project intended to explore the nature and determinants of cross-border interfirm linkages and their effects on management and the creation of economic competencies in SMEs. It relies on both qualitative and quantitative evidence and uses a single case study design. The reason for this choice is that to determine whether and how switching costs arise, and what their characteristics are, we consider it necessary to obtain detailed knowledge about how a specific company conducts its businesses in the chosen industry.

Qualitative evidence was collected in three steps in Spring 2001 (Sørensen 2001). In the first step we assembled general knowledge on the plastic processing industry as a whole. The aim was to get an overview of this very complex industry, and to determine whether the medi-tech plastic industry would prove the best sub-industry to use for our present purposes. In step two we selected and investigated a specific company conducting business in the Øresund medi-tech plastic industry. The aim was to find out how it organized its supplier linkages, and whether certain switching costs could explain the pattern. In step three we interviewed the company's suppliers and customers in order (1) to verify and elaborate on the findings obtained from step two, and (2) to get a more thorough and coherent understanding of the processes that could help explain switching costs. Ten open-ended, semi-structured interviews were conducted with managers of the company, its customers, and its tool suppliers as well as an additional eight interviews with industry experts. To validate the findings, early interpretations were distributed to the interviewed persons.

Quantitative evidence was collected from different sources. A questionnaire with Likert scale format developed in cooperation between one of the authors and an industry expert was distributed to twenty Swedish plastic processing companies in Skåne (the Swedish side of Øresund). Of these, 11 questionnaires were answered and returned. Since there are only about forty plastic processing companies in the whole of Skåne, this response covers approximately 25% of the industry in this area.⁸

4.2 Cross-border regional development in Øresund

The development of the Øresund area into a strong and coherent region (the Øresund Region) has been a highly debated topic over the past couple of years.⁹ The building of the Øresund Bridge, the largest infrastructure project in Europe since the Channel Tunnel, has been the physical manifestation of this vision (Sparrow 1998). Descriptions in the daily business press and on the internet such as *Great expectations as regards the Øresund Region*, *The Øresund Region is an attractive area of investment for foreign investors*, and *The Øresund Region is a region of international top class* are just a few of the many optimistic comments that have flourished in the media since attempts were made at connecting the two areas of Greater Copenhagen in Denmark and Skåne in Sweden.¹⁰ The aim of connecting the two areas has been to achieve economic growth and a strong business area, which in turn would attract foreign investments and hence spur further growth and welfare in the Danish-Swedish community. The formation of interfirm linkages across the sound is

supposedly the glue to connect the two sides of Øresund (Ugebrevet Mandag Morgen 1998).

Tremendous growth in the formation of interfirm linkages across Øresund has been anticipated as the result of symbolically and physically connecting the two areas by building the bridge (Maskell and Törnquist 1999). Especially, cross-border cluster formation was expected to increase profoundly within the internationally competitive sectors that were already strongly represented in the area. These include the maritime sector, the pharmaceutical and biotechnology sector (and within this, the medi-tech plastic industry), the information technology and telecommunications sector, the environmental sector and the food industry. The pharmaceutical and biotechnology sector – known as Medicon Valley – is probably the best known of these cluster initiatives. It has articulated the ambition of becoming Europe’s most attractive bioregion by 2005. Indeed, Medicon Valley might yet become leader in Europe if the integration of Greater Copenhagen and Skåne is successful (Frank 2002).

However, the growth in cross-border linkage participation has not lived up to expectations. According to the Øresund-index, cross-border linkage participation presently ranks 50 on a scale from 0-100, where 100 is the benchmark level of cross-border participation that could be expected if no legal, social and cultural barriers existed (Copenhagen Economics & Inregia 2002).¹¹ Compared to one year ago, this represents only a small increase in such participation (when the comparable number was 43).

Thus, despite further investments in infrastructure, creation of representative network organizations (e.g., the establishment of the Øresund Chamber of Commerce and Industry) and a harmonization of labor market and tax policies, the present situation is characterized by a slow growth in participation in cross-border interfirm linkages (Frank 2002, Maskell and Törnquist 1999). According to Gertrud Bohlin Ottosson, director of the Ideon science park in Lund in Sweden, the only way to increase the formation of cross-border linkages “is to keep on pushing, to arrange more meetings and conferences and to keep discussing the need to further integrate the region” (quoted in Frank 2002, p. 435). However, as noted in a recent study by the OECD (2001, p. 75), the various efforts of creating an Øresund learning region “may not be sufficient to break the ‘path dependence’ of existing traded networks of firms.”

Table 1 below summarizes the extent to which Danish and Swedish firms in the area have formed linkages with firms on the other side of the sound and with more distant firms within their own country. Swedish firms are generally more prone to form linkages with firms across the sound (54 %) than are Danish firms (43 %).

INSERT TABLE 1 HERE

The Øresund medi-tech plastic industry is experiencing a relatively slow growth in the formation of cross-border linkages as well. We have chosen this industry for investigation, because we believe it constitutes a privileged case.¹² Compared to other parts and industries, the Øresund medi-tech plastic industry has received the most attention and support (financial as well as political) in relation to cross-border integration, as it is stakeholder in one of the greatest partnerships formed in the Øresund area – the Medicon Valley Academy (MVA).¹³ However, the majority of firms in the Øresund medi-tech

plastic industry continue to link up with their existing suppliers, which are for the most part spatially proximate firms. This is also evident in our survey analysis. The majority of the Swedish medi-tech plastic companies (82%) rely only on Swedish suppliers, signifying the localized nature of the industry. 45% of the companies furthermore claim that their personal relationships to suppliers that are localized in their near vicinity improve on the success of linkages.

4.3 *The Øresund plastic processing industry*

The plastic processing industry – of which the medi-tech plastic industry is part – is a highly diversified and fragmented industry with a long history. The diversified structure of the industry is mainly a result of the varied nature of the markets served by its companies (see figure 1 below) and of the relatively low barriers to entry. Increasing competition among leading companies in upstream industries (chemical companies, suppliers of raw materials and equipment, engineering companies, toolmakers, and so forth) and downstream industries (e.g., electronics, industrial machinery, transportation, pharmaceuticals and medical devices) are now generating strong pressures for plastic processing companies worldwide to become more competitive and innovative (e.g., by eliminating costs and adding additional processing capabilities). One result is that the industry is now gradually reorganized into a more coherent and structured system of firms, as scale economies become increasingly important for profitability and long-term survival.

INSERT FIGURE 1 HERE

Specialization has meant that some firms focus exclusively on injection molding, while other firms concentrate on either extrusion or thermoforming. The continued participation of small and medium-sized local firms in the industry depends to a large extent on their ability to create new economic competencies to comply with the demands of leading firms in upstream and downstream industries.

The medi-tech plastic industry, that is, the firms manufacturing plastics components for the pharmaceutical and medical device industries (e.g., lab-ware, optical components, electrode housing equipment, cassettes, spirettes, safety cannulas, catheters, biocompatible and radiopaque probe caps, laryngeal prosthetic devices, disposable devices and pharmaceutical packaging), provides a favorable case in terms of investigating linkage lock-in and switching costs. In this industry long-term linkages with suppliers are important, as suppliers are the main facilitators for the learning and innovation necessary to compete in a highly dynamic and increasingly competitive market (Parker 2001).¹⁴

Thus, although the building of a supporting science base has been important for improvements in plastics, the innovation process in most plastic processing companies is still very much incremental, demanding a complex match of development efforts of suppliers, processing companies and end users (Braunerhjelm *et al.* 2000, Hansen and Serin 1989). Especially toolmakers and suppliers of raw material play an important role. Close and enduring contacts to suppliers are important for the plastic processing companies to gain access to specialized knowledge about developments in raw materials and tools. In fact,

forming linkages with toolmakers seems to be a common trait of the Øresund medi-tech plastic industry. Thus, 55% of the companies in the survey analysis indicated that their most important linkages were with the toolmakers, and to some lesser extent with the suppliers of raw materials. For medi-tech plastic firms, both toolmakers and suppliers of raw materials are thus important constituents to consider in order to be innovative and to adapt to market trends and customer's specialized demands.

The function of suppliers in the innovation process depends on their specific knowledge about materials. Overall their job can be defined as facilitating knowledge about materials used in the construction of plastics components. Their task is to either provide the most favorable material for a specific manufacturing process, or to point to the changes in existing manufacturing processes necessary for using existing materials for new applications (Hansen and Serin 1989). Linkages and interfirm learning enable the plastic processing companies as well as their suppliers to specialize, develop customized products, focus on core competencies, and obtain internal scale economies. However, although prolonged innovation processes and incremental learning are vital in the industry, companies occasionally also need to change suppliers in order to gain access to new resources and capabilities (Teece 1986). This is especially important in dynamically competitive markets where change might render the capabilities of existing partners obsolete (Afuah 2000, Afuah and Bahram 1995). This leaves the firm with the difficult choice of either staying with their current supplier or switching to a new supplier, for which the change has not been competence destroying. In such instances, it becomes essential to determine the nature and significance of lock-in and switching costs.

If high learning opportunity costs are the reason for not switching partners, and therefore constitute part of an explanation for the slow growth in the formation of cross-border linkages in the medi-tech plastic industry, it is likely that similar industries are even worse off in terms of high switching costs, as the medi-tech plastic industry has had the best preconditions for instigating such linkages.

4.4 Presentation of the case company and its supplier linkages

The case company in this study is a small Swedish medi-tech plastic company with about 40 employees, subsidiary of a large Swedish producer of polymer materials. It started out in the early 1980s as a company manufacturing medical components. Nowadays, it has specialized in the development, manufacture, and processing of complex injection-molded plastics components for the pharmaceutical and medical device industries. The company is a well-known actor in the Øresund area, and since it is known to be highly professional, flexible and reliable it benefits from a good reputation among customers, suppliers, and competitors.

The company cooperates with many different supplier firms, which can be segmented into five groups: Machine suppliers, design suppliers, raw material suppliers, master batch suppliers (who can add special features to raw materials, such as, colors and scratch free surfaces), and toolmakers (supplying the generally complex and expensive form tools in which the raw material is injected so as to produce injection-molded components).

While the Swedish medi-tech plastic company has some tool production in-house and has its own tool-making department, its most frequent and closest linkages are indeed

with toolmakers. This is likely an illustration of the more general claim that in industries where knowledge is widely distributed and brings a competitive advantage “companies must be expert at both in-house research and cooperative research” (Powell *et al.*, 1996, p. 119). Keeping some tool making in-house may thus be a way for the company to build and maintain absorptive capacity necessary for successful interfirm knowledge transfer (see also Grandstrand *et al.* 1997).

Since the company’s most frequent and closest linkages are with toolmakers, some of these have been chosen for the present study. More precisely, we have chosen to study the company’s linkages with two Swedish toolmakers and one Danish, all of which the company has cooperated with for about a decade. Independent of size, the tool suppliers for this particular industry are generally distinctive in terms of the products and services they offer. Most toolmakers specialize and possess specific capabilities within a narrow range of activities. Some toolmakers, however, offer a broader portfolio of products and services within machine construction, tools, and plastics components, and therefore to some extent resemble the plastic processing companies they service.

The company participates on a regular basis in linkages with ten toolmakers, most of which are small Swedish firms in its near surrounding area. This might be troublesome, since it appears that Swedish toolmakers in the area have some problems in establishing themselves as an industry (Parker 2001). Furthermore, the company has only little cooperation with Danish toolmakers, even though these provide tools of very high quality and might possess the additional processing capabilities needed for the company to innovate and develop its competitive advantage.

This linkage pattern is indeed remarkable, since strategic factors such as quality, service, timing, and reliability are perceived more important to competitive advantage in the plastic processing industry than cost efficiency (Hansen and Serin 1989), and since the presence of alternatives should step up the choice of switching partners.¹⁵ It motivates the questions: *Why does the company not form more linkages with toolmakers across the sound?* An opening answer to this question is that it has likely reached a level of commitment with its existing suppliers to such an extent that motivational forces (including learning opportunity costs) act to maintain the linkages, even if better alternatives in terms of quality and processing capabilities exist.

Could the company then organize better for competitive advantage by forming linkages with Danish companies? Our analysis suggests an affirmative answer to this question, since Danish toolmakers have better education, government support and more skilled people than their Swedish counterparts. The medi-tech plastic company is itself attentive to this fact. Exactly for these reasons, they believe that some Danish toolmakers deliver products of a higher quality than Swedish toolmakers. When asked whether Swedish toolmakers possess capabilities that Danish toolmakers do not possess, the project manager of the medi-tech plastic company replied that Swedish toolmakers are no better than their Danish counterparts, and that he could think of no comparable advantages of Swedish toolmakers. Forming linkages with Danish toolmakers could thus provide the Swedish medi-tech plastic company competitive advantage compared to other Swedish firms in the industry.

The first Swedish toolmaker investigated is located geographically very close to the company, and the initial contact between the two companies was established through

personal relationships. The two companies have cooperated closely on an informal basis for more than ten years. Over this time-span they have come to know about each other's products and processes, and the medi-tech plastic company keeps this supplier constantly updated on the latest developments. Interaction between the two companies depends on a few key persons (the manager and the CAD/CAM constructors of the supplier company interact with the project manager and the sales team of the medi-tech plastic company), and this is believed to ease the flow of knowledge and information and facilitate short-term exchange.

The linkage with the second Swedish toolmaker is very similar to the one just described, although the second supplier is located more distant from the medi-tech plastic company. This linkage is also about ten years of age. The initial contact was made at an industry fair where the medi-tech plastic company approached the supplier, because it had been recommended by one of the medi-tech plastic company's existing customers. Since then, the two companies have cooperated closely, also on an informal basis. Interaction takes place between only one individual in each company.

The linkage with the Danish toolmaker is somewhat different from the two just described, although it is also characterized by close cooperation and interaction among a few individuals. The Danish toolmaker is located outside the Øresund area, remote from the Swedish company. The linkage was established about seven years ago through the personal network of the managing director of the Swedish company. Language differences, as emphasized by the Swedish company, constitute the main barrier for cooperation in this linkage.

5. Switching costs in the medi-tech plastic company's supplier linkages

Based on the interviews with the medi-tech plastic company and the three toolmakers, figure 2 below illustrates the different interactions in a typical exchange episode between the case company and its toolmakers.

The initial phases until the actual production of a tool, where immense communication and information exchange takes place, are all critical. Through the processes leading up to the actual production of a tool (see flow 1-6 in figure 2) the parties interact once a week, sometimes even twice a week, exchanging ideas in tacit as well as explicit outline and engaging in joint project development. The phases illustrated by flows 1-6 can perhaps best be conceptualized as a mediating specification process (Nellore and Söderquist 2000). In such a process, specification is based on dialogue and is jointly shaped by the different participants in project development.

When the actual production of a tool starts, only few exchanges take place. To the extent that short-term exchanges occur in the production phase, it is often because there is a problem with certain features of the product, or if the medi-tech plastic company's clients change their requirements.

INSERT FIGURE 2 HERE

Long-term knowledge transfer leads to the development of relatively stronger linkages. For example, initial exchanges become routinized and thus made less time-consuming.

Moreover, the case company and its three toolmakers successively built up linkage contact patterns and role relationships. Employees experience that these patterns and relationships reduce uncertainty, create mutual trust, and reciprocally commit the firms. The toolmakers adapt to the medi-tech plastic company through customization of components (involving qualities, material, and different aspects of the production process), and through customization of information needs and delivery conditions. The case company adapts its production processes and procedures to the capabilities of specific toolmakers as these, because of the complexity of developing a certain tool, sometimes request more time. In such instances, the case company must adapt its planning and scheduling activities accordingly.

There are no critical differences in the ways the medi-tech plastic company interacts with Danish and Swedish suppliers. The three linkages are all characterized by recurrent and strong interaction. These include all kinds of short-term exchange ranging from information exchange over product, service, and financial exchange to social exchange. As a result of the repetition of the exchanges (and the fact that the linkages are all long-term) trust, common codebooks, and information channels are established, resulting in a transfer of information and the creation of new knowledge in short-term as well as in long-term exchange episodes. Moreover, we found that the firms are generally good at understanding the knowledge transferred (absorptive capacity) and to present knowledge in a sufficiently codified form (communicative capacity), enhancing the information transfer and the creation of new knowledge in the linkages.

5.1 *Cognitive costs*

The knowledge to be transferred in the investigated linkages is in some situations tacit and in other situations explicit. However, a clear-cut distinction between the two is difficult to make, since the activities around knowledge transfer and learning involve complex organizational routines for interacting across firm boundaries, different organizational cultures, opinions, skills and capabilities. In fact, several of the phases in figure 2 involve activities that require the coordination and integration of different types and levels of knowledge to be effective.

When exchanging information concerning certain specifications in the initial stages of an exchange episode (see flow 1 and 2 on figure 2), or when commenting on the CAD/CAM drawings, the knowledge to be exchanged is rather explicit in nature, as specifications are often written down, and as the comments concerning the toolmakers' drawings are typically technical expressions that both of the interacting parties can relate to. In these instances, no immediate costs subsist in the investigated linkages. On other occasions, the knowledge to be transferred is tacit. For example, when the medi-tech plastic company has to explain certain routines in their own tool production, this knowledge is personal and thus hard to formalize and communicate. The specificity of the knowledge and the codification process adds to this problem.

However, similar knowledge bases and shared codebooks among the firms in the examined linkages, established through many years of cooperation, can be seen to somewhat offset cognitive costs. For example, both the key account manager in the medi-tech company and the managing director of the Danish tool company believe that barriers stemming from language differences have become less of a problem as the two firms have

come to know each other better over the years. Thus, cognitive costs concerning the nature of the knowledge are generally low in the investigated linkages. This finding supports the argument that shared codebooks work to lower cognitive and information costs, and that such codebooks are essential for the successful transfer of knowledge and information (Lorenzen 1998, 2002, Cowan *et al.* 2000, Lissoni 2001). It also shows that interfirm knowledge transfer and learning might involve more than just the nature of knowledge. Interfirm knowledge transfer and learning depend as much on how the firms integrate the different types of knowledge into products and coordinate the many activities around diverse exchange episodes.

In the investigated linkages the main knowledge channels are telephone, e-mail, and specifications. However, sometimes also personal face-to-face meetings take place, especially during the approval phase where the medi-tech plastic company has to see the CAD/CAM drawings. Thus, personal face-to-face meetings are used when there is a chance that the knowledge transferred could be misunderstood and misinterpreted. Through personal meetings it is possible to determine if knowledge has been sufficiently codified.

Hence, in the investigated linkages a good match between the sharing mechanism (or knowledge channel) and the nature of the knowledge is found. Personal sharing mechanisms are applied when knowledge is tacit or otherwise difficult to transfer, whereas impersonal sharing mechanisms such as telephone, mail, or product specifications are applied when transferring explicit knowledge. Consequently, the cognitive costs concerning the knowledge channel are low in the linkages. The respondents have developed the ability to distinguish a situation when knowledge is complex, and adjust their routines for knowledge transfer accordingly (e.g., by arranging personal face-to-face meetings).

The interacting parties come from very different organizations and different organizational cultures. The two Swedish suppliers are relatively small, whereas the Danish supplier is large. The differences in size should influence cognitive costs, because knowledge in large companies often has to pass many people or sub-units before the actual transfer. However, this is not the case in any of the investigated interactions, as the contact persons also are the ones responsible for the absorption and application of the knowledge in the linkages.

Yet, the Swedish medi-tech plastic company expressed that it is generally difficult to communicate with Danish toolmakers because of the regularly hierarchical structure in Danish tool-making companies. They claimed that in Danish tool-making companies, a superior always has to approve all decisions. This makes the decision-making process slow and instigates inflexibility and slow response time to adapt to internal and external changes. This supports the findings of Lyles and Baird (1994) that a non-bureaucratic and non-hierarchical organizational structure is associated with a higher absorptive capacity. According to the Swedish medi-tech company, problems with internal communication within the Danish tool company have caused it to misinterpret certain important information and knowledge. This is not the case with the smaller Swedish toolmakers. Consequently, certain cognitive costs concerning the knowledge senders and receivers are prevalent when interacting with the Danish toolmaker, whereas no costs are found in the interactions with the Swedish toolmakers.

However, as the medi-tech plastic company has been interacting with the Swedish toolmakers, as well as with the Danish supplier, for many years common codebooks, information channels, and a common body of knowledge has been established, contributing to the reduction of cognitive costs, especially in the interaction with the Danes. Moreover, owing to their experience in mutually transferring information they have developed shared codebooks, and cognitive costs are thus reduced.

5.2 Information costs and costs arising from cross-border differences

At first, none of the interviewed parties directly expressed their lack of information about other potential suppliers. They primarily find new suppliers via their personal networks, and as they believe their personal networks cover an unrestricted and wide geographical territory, they do not consider lacking important information potentially leading to information costs. Indeed, forming linkages with spatially proximate firms seems to be a prevalent characteristic of the industry. Thus, nearly half (45%) of the companies in the survey analysis state that they select suppliers from their personal network, and that their personal relations to local suppliers are better than those to more distant suppliers.

However, later in the interviews – and when interpreting the statements – it became evident that especially the smaller toolmakers suffer from a lack of information about potential new constellations that could lead to increased learning. The interviewed toolmakers lack sufficient information concerning the possibilities of linking with other firms outside their personal and geographically limited network. As one of the Swedish suppliers explains, “I do not understand Danish very well. Therefore, I would need an interpreter if I were to consider entering the Danish market.” Another Swedish supplier explains that he knows nothing about the opportunities for cooperating with new customers on the Danish side of Øresund.

In conclusion, the fact that the interacting parties belong to different national innovation systems accentuates the information costs identified above. New partners are primarily reached through personal networks, and knowledge about potential suppliers is nested in these networks, the result being that information and networks circulate on the respective sides of the sound and not across it, increasing overall switching costs and leading to less economic and social integration of the areas.

5.3 Learning opportunity costs and overall switching costs

The investigated linkages are all characterized by modest costs. Cognitive costs are present in the linkages when transferring highly tacit knowledge (the nature of the knowledge), but mostly when interacting with the Danish toolmaker. They are reduced through the existence of common codebooks, information channels, and the development of common bodies of knowledge. Information costs prevail in many, but not all interactions and are magnified by costs arising from differences in innovation systems.

Learning opportunity costs and switching costs are high in the medi-tech plastic industry, as information transfer and the creation of new knowledge are difficult in new linkages, where common codebooks and information channels have not yet been established. These costs are furthermore amplified by information barriers, and thus information costs and costs arising from cross-border differences. This generally inhibits switching and works against the

successful regional development of the Øresund area.

6. Conclusions

The paper has contributed empirically with explanations as regards the lack of increased participation in cross-border interfirm linkages in the Øresund medi-tech plastic industry. It explains that high learning opportunity costs, and thus switching costs, prevails in this industry and in this specific area, because learning is essential to the competitiveness of firms operating in this context. By switching suppliers, cognitive costs are temporarily increased and this might lead to lost opportunities for learning. Moreover, information costs about other suppliers in other geographical areas, and costs accruing to differences in innovation systems, amplify learning opportunity costs, as a lack of information about other suppliers can lead to lost opportunities for learning. Consequently, the paper explains that increased participation in interfirm linkages across Øresund is tardy in the case of the medi-tech plastic industry, as there are learning opportunity costs associated with switching to other suppliers in this industry.

The paper has also contributed insights that can serve as a foundation for initiating new policy measures aimed at decreasing switching costs and thus support participation in cross-border linkages in the Øresund area. As the current situation is characterized by high switching costs, the important aim is to reduce these so that the advantages of initiating cross-border linkages will become greater than the advantages of staying with current partners.

A number of research issues might be addressed on the basis of the present analysis. First, it would be interesting to inquire into other industries that do not resemble the medi-tech plastic industry. Studying dissimilar industries would enhance the overall understanding of switching costs in interfirm linkages and their influence on regional economic development. Comparing the findings from different types of industries would serve to further elaborate on the concept of switching costs in linkages, adding to our understanding of what kinds of barriers exist. This would be valuable for finding possible solutions to increase participation in interfirm linkages in other regional, or cross-border settings.

Second, research into the actual complementarity of the Danish and Swedish areas would be highly relevant. For example, it has been stated that within biotechnology the two areas of Zealand and Skåne are substituting, rather than complementary, with the result that a lot of the research carried out is redundant (Berg *et al.* 1997). A more thorough investigation of whether also plastic processing companies substitute, rather than complement each other would be interesting, as this might prove a useful starting point for attempts at reducing redundancy and increasing the incentives to switch to new partners across Øresund. It would also add to a more complete picture of the concept of switching costs.

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Table 1. Interfirm linkages in the Øresund area, May 2002.

Linkage formation patterns	Swedish firms	Danish firms*
Distant within-country linkages†	63 %	50 %
Cross-border local linkages	54 %	43 %
Formal linkages‡	74 %	79 %
Informal linkages	25 %	21 %

* The survey results reported here include 110 Swedish and 115 Danish firms.

† For Swedish firms in the Øresund area distant within-country linkages include linkages with firms in Stockholm. For Danish firms in the area they include linkages with firms in Jutland and Funen.

‡ Formal linkages include subsidiaries, joint ventures and written subcontractor agreements.

Source: Copenhagen Economics and Inregia (2002, Appendix 2, p. 3).

Figure 1. The plastic processing industry

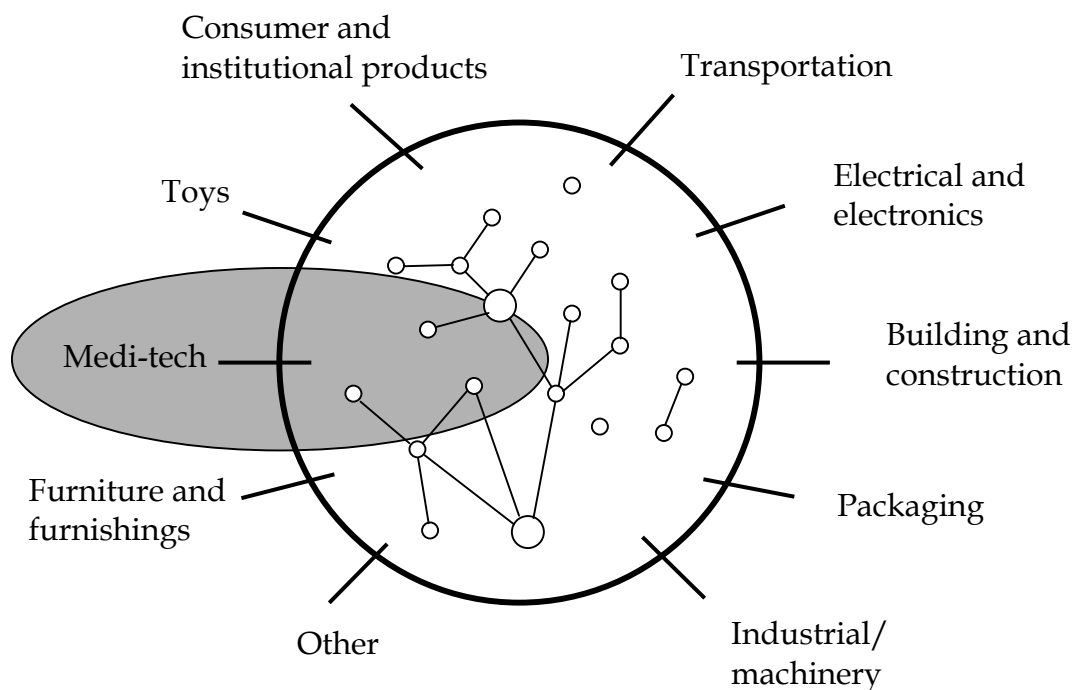
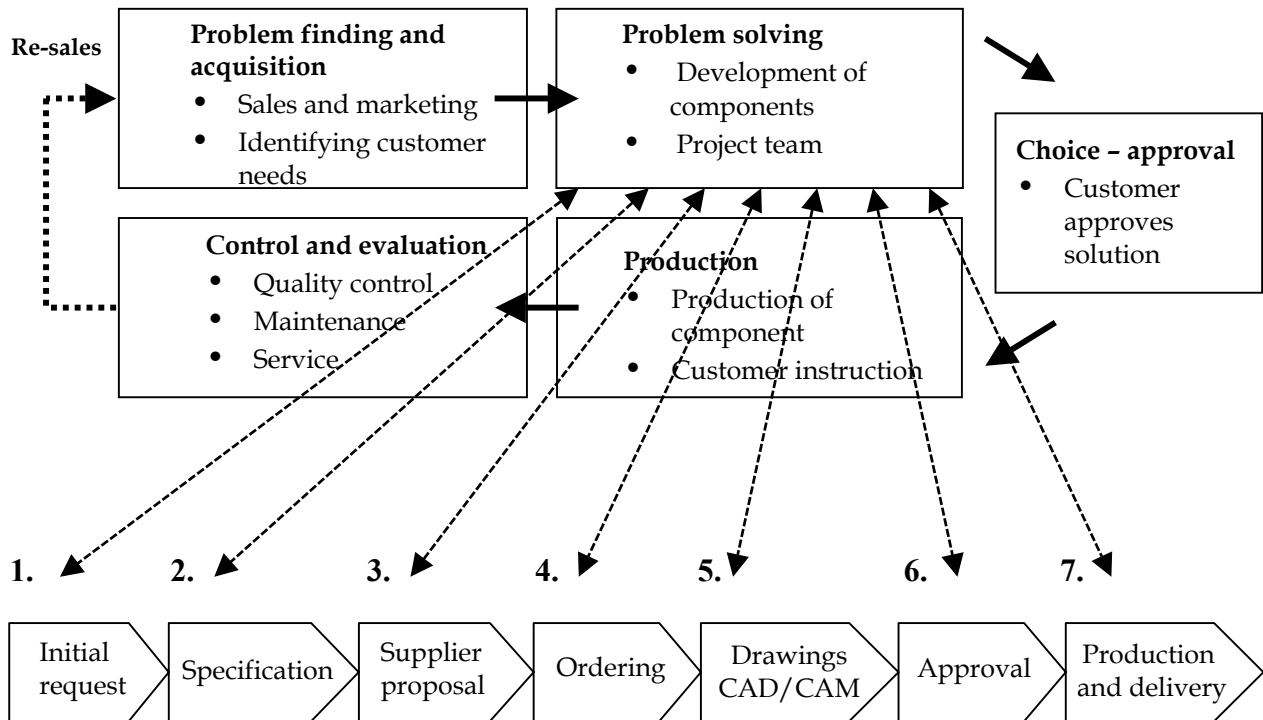


Figure 2. Interaction between the medi-tech plastic company and its tool suppliers



Notes

1. Consider, for example, the rapid economic developments in the industrial districts of Japan and the Third Italy as well as in Silicon Valley, Boston, and the M4 corridor in the UK. In all of these cases, linkages between firms, and between firms and other organizations (local municipalities, universities, and so on), have been essential for achieving international competitive advantage and economic growth (Becattini 1978, Best 1990, Langlois and Robertson 1995, Lazerson 1988, Sabel 1992, Saxenian 1991, Storper 1992, and Storper and Scott 1992).
2. Kogut (2000, p. 411) argued that, because the rules generating cooperative behavior are socially and technologically dependent and the product of non-randomly distributed knowledge, the way interfirm linkages evolves is sensitive to specific industry settings. By implication the evolution of linkages is also sensitive to differences in national culture.
3. Of course, one can argue that even price differentials may be biased, as the price paid to a supplier may be the result of ex ante coordination through prior contractual commitments and personal relationships (Imai 1990, Langlois 1995).
4. Our use of the term *learning opportunity costs* as applied to linkage formation is somewhat akin to the term *learning costs* as used by Klemperer (1987) and extended by Nilssen (1991). We wish to reserve the noun *opportunity* to the situation where learning costs *prevent* a firm from switching suppliers.
5. According to Grant (1996b, p. 115) common knowledge comprises in its most simple form, those elements of knowledge common to the interacting parties, i.e., common knowledge is “the intersection of their individual knowledge sets.” The development of common knowledge allows the parties to share and integrate those aspects of knowledge that are extraordinary between them.
6. It is important, however, to stress that information costs not only influence learning opportunity costs, but also other costs such as, for example, incentive related costs. This is because a lack of information (or perhaps access to incomplete or incorrect information) about new suppliers might lead a firm to distrust a potential new supplier. However, a further description of how information costs might influence other costs is beyond the scope of this paper and will not be pursued further.
7. On the other hand, when studying how Hungarian firms acquired knowledge from foreign parents in international joint ventures, Lyles and Salk (1996) demonstrated that only on occasion might cultural differences negatively impact on knowledge acquisition. Instead, they found that the structuring of linkages, as well as the absorptive capacity of the participating firms, were much more significant influences on knowledge transfer.
8. Thus, the plastic processing industry in Skåne is small, especially when compared to other countries (e.g., UK or the US). For comparison, Bernard *et al.* (2000) estimate there are about 4,000 plastic processing companies in the US. One of the reasons for the small size of the industry in Skåne may be that the area has no strong chemical industry and thus may lack industrial competence in chemistry and chemical engineering (Braunerhjelm *et al.* 2000).
9. The question of a physical link between Denmark and Sweden has actually been discussed for more than a hundred years (Maskell and Törnquist 1999). In June 2000 the Øresund Bridge opened. This is a huge construction of about eight kilometers connected with 558 meters of viaduct at Pepparholm Island.
10. For examples, please visit www.bgoresund.com.
11. Since 2001, the *Øresund Chamber of Commerce and Industry* has published the Øresund-index annually. It is based on surveys of firms in the area that are members of the Chamber. On the basis of their answers, actual business activity across the sound is analyzed in relation to benchmark activity, where the benchmark is based on the assumption that without barriers, cross-border activity would likely compare to within-country activity. For Danish firms in the area, the benchmark represents the value of linkages with firms in Jutland and Funen. For Swedish firms, the benchmark represents the value of linkages with firms in Stockholm.
12. The Øresund area is a privileged case as regards the influence of switching costs and their determinants on regional economic development, simply because it is a cross-border area. This means that cognitive, information and learning opportunity costs are likely to be relatively high for firms looking for partners

on the other side of the sound. The medi-tech plastic industry is a privileged case in relation to the rest of the plastic processing industry, as it has had the greatest preconditions for forming cross-border linkages. Thus, we consider conclusions from this part of the industry valuable as regards contributing insights to explain linkage formation patterns in the rest of the plastic processing industry as well.

13. Medicon Valley Academy is a joint non-profit organization for bio-medical firms in the Øresund area. Its members have a combined turnover of SEK 32 billion and represent 60% of Scandinavia's output within the bio-medical sector. The objective of the Academy is to promote the development of the sector by acting as a conduit for linkages between universities, firms, and authorities (please visit www.mva.org).
14. Plastic processing companies are in general competing in a growing market. For the medi-tech plastic industry, social factors influence markets and lead to increasingly competitive conditions. For example, owing to the aging of population, health expenditures are increasing in the Øresund area. With this development, drug delivery systems enabling self-treatment of patients become a basic area of application and hence of innovation by firms in the industry. Also, competition from low-cost countries on more simple and standardized medical devices is expected to increase.
15. In fact, the importance of factors such as timing and reliability underscores the complex pattern of interfirm linkages necessary for developing and manufacturing plastics components for the pharmaceutical and medical device industries. In the interviews, two customer firms stressed that timely delivery of components is an important factor for an efficient production process in the buying companies.