THE POLITICAL ECONOMY OF PRODUCTION SYSTEMS

Power, Governance and Learning in Industrial Networks

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Preface

This study aims to contribute to the academic debate on the internationalisation of the economy and technology, looking in particular at the effects of the restructuring process of industrial production activities on the small enterprises. The rationale for the study is based on the emergence of complex networks of production and the creation of different markets within the same geographical space. Long-distance networks crossing national borders and economies, together with the re-discovery of very dynamic molecular forms of capitalism, territorially defined and oriented towards small enterprises, has made the process of innovation, its sources (and hence the sources of advantages of regions and firms) increasingly difficult to detect. The literature on the learning region, the global commodity chain, and new industrial districts is representative of the attempt to explain why certain areas forge ahead while other lag behind in a very volatile economic environment. At the same time, despite the vastness of the literature on innovation produced in the last decade, especially that concerning the industrial sector, very little was added to the analysis of the consequences of innovation processes for the general welfare of all men and women of a given territory, and not just of specific firms or clusters of firms.

The thesis attempts to contribute to this intellectual debate by focusing particularly on small firms in low-technology sectors. The choice to focus on the small low-tech firms was made with two main considerations: firstly, the fact that small and medium-sized enterprises in the low technology sectors represent a major share of the industrial firms in Denmark and in the European Union -therefore they are an important stronghold for national economies and employment; secondly, the

closeness of low-wages countries, the Baltic countries and Poland in particular, puts Denmark in a vulnerable position in relation to the processes of de-localisation.

The novelty of this thesis lies in the introduction of a systemic analysis of the interrelations between forms of governance, learning processes and markets dynamics. This approach enabled me to raise other theoretical and empirical questions regarding, especially, the sustainability of the learning and innovation processes in firms, as well as innovation as a strategic and reflexive process. The introduction of the concept of sustainability of learning is concerned with the fact that policies and strategies which do not take into account the effects that each innovation has on the system as a whole will not be able to prevent the erosion of the knowledge base of national economies. This failure is due to the continuous disappearance of weaker and smaller firms from the scene. In this regard, in the thesis a particular attention was paid to the distinction between radical and incremental innovation. Instead, the strategic reflexivity of innovation has served the purpose to analyse the more general problem of the dynamic of appropriation and diffusion of technology and knowledge within complex systems of firms.

This study has been carried out within the framework of the PhD Program “Innovation Studies, Technology Policy and Socio-economic Development” at Roskilde University, which was later renamed “Society, Business and Globalisation”, the programme provided the financial support for the thesis. The research has benefited from inputs from several sources. First and foremost has been my participation in the Innovation Research Group at the Department of Social Sciences. During these meetings I had the opportunity to present the drafts of the various chapters of this thesis,

discuss conference papers, engage in intellectual and challenging discussions with my colleagues, and receive useful feedback and positive encouragement to continue the work. Similarly, participation in the PhD students' research seminars provided a forum for presenting the research as it progressed, and for receiving comments from my colleagues. In Denmark, complementary to these activities I joined, in 1998, the Summer School at Aalborg University organised by the national PhD Programs Network.

Parallel to participation in local initiatives, I have been affiliated to different international networks of researchers in industrial and innovation dynamics. In particular, I have participated in two sessions of the European Summer School on Industrial Dynamics (ESSID), in 1999 and 2000. This gave me the possibility to meet and discuss my research project with an international group of renowned scholars in the field. During the same period I joined the group on Industrialisation Strategy of the European Association of Development Institute (EADI), which provided the forum for discussing recent developments in international research into small and medium-sized industrial firms. In addition, my work as director of studies of the European Master Program in Science, Society and Technology has given me the opportunity to join the ESST Research Network and participate in its annual conferences. Finally, an important source of intellectual stimulus was provided by my participation in the international meetings and seminars on Globalisation organised by the Federico Caffè Centre, both at Roskilde University and in the other institution members of the Centre's networks. In this regard, it is particularly important to mention the yearly seminar that has taken place since 1999 at "Città della Scienza" in Naples organised by the Meridione Network, and the research seminars on Globalisation and Production Systems Analysis in 1998 and 1999 at the

University of Chapingo, Mexico and in 2002 at the University of La Havana, Cuba. These research and training activities have been complemented with participation in international conferences and seminars that resulted in the publication of some of the papers either in scientific journals, or as contribution to anthologies.

The genesis of this thesis is, for these reasons, the outcome of an articulated process of research and training activities that unfolded in very different academic environments. This has undoubtedly provided the ground for a cross fertilisation of research methods and traditions, the benefits of which have only been possible to reap by being affiliated to an institution such as Roskilde University. Hopefully, the thesis reflects this heterodox approach.

CHAPTER ONE

Researching into Contemporary Industrial Production Systems: Introduction, the Research Problem and the Method

1. Introduction

The dominant economic ideology of the 1990s' represented by the duo of de-regulation and liberalisation has paved the way for a process of economic and political restructuring that has involved all social, political and economic actors.[1] This has resulted in a very volatile economic environment, highly dependent on the fluctuations of financial markets and the speed of technological innovation. The adjustment to these new conditions has in turn provoked the downsizing of large companies, the spreading of flexible technologies, the privatisation of many public companies, and a new jump in the level of internationalisation of productive activities. Hence leading to shorter products' life cycles, hypercompetition, and increasing markets opportunity.[2] If traditionally, competition was based either on cost or on the ability to supply new products, today both factors are present and teeming. In fact, while industrial restructuring was previously considered a temporary stage during which industrialised countries adapted to lower growth rates and adjusted to the entrance of new players, such as Japan and the newly industrialised

[1] In the last decade, a very large number of articles and books has been published on the globalisation of the economy and technology, ranging from the more critical analysis of Petrella (1999), Sklair 2001 and Amoroso (1998) to the more mainstream of Archibugi and Michie (1998), Archibugi and Imperatori (1997), Cantwell (1997) and Dunning (2000), just to name a few.

[2] Cf. for example, O'Shea and McBain, 1999; Oakes and Lee, 1996; OECD, 1996; Kotha, 1996.

countries; today, it is a deliberate strategy of industrial firms in the industrialised countries to regain control over the production process (Ruigrok and van Tulder, 1995).

With regards to the industrial sector, the production system that dominates today is the outcome of a change in the organisation of industrial activities, which started in 1970s with the process of "productive de-centralisation".[3] This change continued throughout the 1980s with an impressive wave of mergers and acquisitions, and culminated in the 1990s with the spread of the "outsourcing" mania. After the first oil crisis of the seventies, large companies started to reduce employment dramatically, while the separation of work tasks into different production units contributed to the diffusion of specialised small firms, which were either very dependent on the large ones, or very autonomous. This phase of corporate capitalism was followed by a process of concentration in many industries, this was achieved through the acquisition of competitors by a handful of transnational companies. Large companies started to engage in large budget research projects and create monopoly situations. As a consequence, they strengthened the specialisation in the core competencies and the control over those operations considered of having a strategic importance, such as research and development and finance.[4] Production was subcontracted and outsourced to small suppliers with different levels of specialisation and importance in order to share risks and costs among many firms.

Obviously, a deeper understanding of the dynamic and growth of these processes becomes central for policy makers, especially for the consequences they have for the economic structures, employment and

[3] Graziani, 1989, p. 82-85.
[4] See for example Amoroso, 1999.

markets, and therefore on general welfare creation and distribution of the region/country in which the production systems are localised.

Not surprisingly, much of the debate concerning what forms of industrial sector are more conducive to higher levels of productivity has proceeded on the basis of case studies of production systems and regions, and especially on the "success stories" of some scattered industrial clusters.[5] Although these success stories provided some important critical insights into the paradigms of industrialisation and local development, our ability to understand their success and their developmental trajectories or to draw policy implications is still limited (Harrison and Storper, 1991). Terms and concepts, such as production systems, industrial districts, networks, and so on, as well as their dynamics, are contextual or context-dependent, and therefore generalisations are difficult to draw. Furthermore, firms and networks are part of systems, the dynamics of which depend on the combination of both internal (power structures, resources, etc.) and external factors, such as the technological development, the institutional framework in which the agents are embedded and the markets dynamic. Therefore, the most appropriate 'practice' to foster an industrial system able to provide the growth and development of all the networks' participants has yet to be discovered. Nor will it be, for what works in one context does not work in another.

By giving central importance to the interrelation between factors such as governance, power, capability development and the market dynamics, this study will contribute to the understanding of the political economy of industrial dynamics. This is done with the aim of providing a more

[5] It would be impossible to provide a list of articles and research papers on successful local industrial systems without being unfair to someone. See for example the often-quoted studies of Saxenian, 1991 and 1994; Markussen, 1996; Kenney and Von Burg, 1999, and the examples in Storper, 1997, to re-construct a partial list of references on the subject.

encompassing analytical framework for the study of the dynamics of innovation and the sustainability of learning in industrial systems. This also means integrating the various elements which come from the different debates relating to the issue of international restructuring.

The thesis derives its eclectic framework from the mixture of different approaches, including strategic management theory, the theory of the firm, organization theory, innovation theory and economic theory, and aims to provide a heuristic qualitative tool of analysis, which is supported by empirical material. Due to the impossibility of mastering all the risks connected with this approach, it is from the outset necessary to warn the reader about the deficiencies and weaknesses that will emerge as the discussion progresses.

This chapter is organised as follows: section two presents two parallel theses on industrial dynamics. The first one is the dependency-based approach to industrial organisation which was developed by Harrison in the early nineties, and the second is the complex approach to industrial networks developed by Belussi in the late nineties. Section three attempts to make a preliminary synthesis introducing a third approach based on the structural dimension of inter-firms relationships. In section four the research objectives and problems are defined and the main hypothesis presented. Section five provides the overall structure of the thesis. The methodological aspects of the research are presented in section six. In this section, the rationale behind the selection of the case study, the process of data collection, and in particular the problems related to their measurement, are discussed.

2. The state of the art: "Concentration without centralisation" and the emergence of the "relational firm"

The new forms of capitalism which emerged after the oil crisis, such as Toyotism and flexible specialisation (Piore and Sabel, 1984; Sabel and Zeitlin, 1985, Sabel, 1994) have contradicted the logic of transaction cost economics in the sense that components with high assets specificity, a high frequency of transactions, and a high degree of uncertainty have to be produced in-house. According to Powell, the network approach has extended the options available to a firm as presented by the Williamson transaction cost approach (Williamson, 1975) to make, buy or cooperate (Powell, 1990). While Williamson provided only a general perspective for the study of industrial restructuring and concerning the factors determining a firm's most optimal form of organisation, the network approach has gained momentum by explaining that the firm is an organisation for managing team production rather than an institution for managing transactions (Grant, 1996a). Transaction cost economics predicts greater integration of firms' functions in situations of uncertainty, while in the network approach an increase in complexity and variability of markets and technologies increases the need for external partners supplying complementary cognition (Teece 1986, in Noteboom, 1999b). Networking does not entail loosing control over production. Toyotism, for example, includes rigorous control mechanisms to guarantee price level, quality and prompt delivery of inputs (Ruigrok and von Tulder, 1995).

The recent focus on systems of firms and the re-organisation of industrial production has not only contradicted transaction cost economics. It has also contributed to stimulating a very lively debate on what form of

governance structure is more conducive to industrial development.[6] More precisely, the focus has shifted from whether industrial complexes are based on vertically integrated or de-centralised structures or a mixtur of both, to their internal organisation. This change has meant the shift from the dichotomy of large *versus* small firms (large is beautiful or small is beautiful) to that of powerful *versus* less powerful corporations. At the base of this shift of focus there is the trend towards the emergence of core competence-based processes of industrial concentration. In some cases, this has generated a process of de-centralisation of less strategic activities and created new forms of dualism. The implications of this process are twofold: on the one hand, the broad menu of institutional alternatives that this process encompasses poses a challenge to the formulation of government policy; on the other, there is not an'all-encompassing' conceptual framework that can explain the different trajectories of industries. Although these may seem mundane assertions, until now most of the existing literature on the subject have implied otherwise.

The process of de-centralisation of production has contributed, on the one hand, to the creation of constellations of dependent small and medium sized subcontractors. On the other, it has induced a process of diffusion of independent enterprises, linked to various extents and with different types of agreements in production networks. How much of this comes from the bottom through a process of "contamination" or "spill-over", or from the top through a process of deliberate "sourcing-out" is not clear. Yet, it has been largely demonstrated that in the former case, we might face a process of endogenous development and the creation of backward and forward

[6] See for example Robertson and Langlois (1995) discussing Lazonick, Porter and Piore and Sabel.

linkages.[7] Whilst in the latter, at the base of the firms' strategy there is basically the need to transfer the risk connected with the production and the volatility of markets, while enjoying the comparative advantages of different countries for each different product. Paradoxically, these new forms of industrial organisation have created a situation in which the sectors less internationalised, less R&D intensive and dominated by traditional small enterprises are those more affected by the process of internationalisation (OECD, 1996).

2.1. Concentration without centralisation

A decade ago, the analysis of the current forms of governance in the industrial sector, from the perspective of power structures, was eloquently captured by Bennett Harrison's notion of "concentration without centralisation".[8] There are two central ideas in this perspective.

The first one is that large firms maintain the control over the strategic core functions and distribute the non-core activities to a multitude of subcontractors. This has marked the birth of the *hollow corporation*, which is specialised in the less tangible and more rent-yielding phases of the value chain (research, design, etc.). Meanwhile, the manufacturing operations are carried-out by tiers of subcontractors that can be easily replaced, with different costs depending on their importance in the network.[9]

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[7] I say might, because the increasing establishment of global value chain are re-organising the linkages and hence new types of hierarchies and distributive effects on the territory. On this last point, see also the study of Rabellotti on an Italian shoe district, 2001.

[8] Harrison, 1994.

[9] The example of Nike (trekking/sport shoes) is enlightening: production is 100% outsourced. The firm is specialised in pre- and post-production activities (R&D, design, engineering, marketing and distribution). Subcontractors are divided into exclusive developer partners (high quality segments) and volume producers (low quality segments). Both are localised in newly industrialised countries. Cf. Belussi *et al*, 1998. See also, OECD 1992, p. 13. But this is also the case of other clothing companies such as Benetton, Diesel, Fashion Box and Replay. Studies on the effects of these types of relationship on the low quality segments subcontractors are very few, and even less on the effects on the local economic environment.

The second one is linked to the first. Today, large enterprises are leaner than ever, and are occupying spaces and niches that were traditionally the domains of smaller companies. As pointed out by the OECD and by several authors,[10] large companies are increasingly flexible and able to produce "mass-customised" products. The process of concentration without centralisation has produced both a dramatic competitive pressure on small firms to enter the strategic tier and a general trend towards the reduction in the number of suppliers.[11]

For these reasons, studies on the role played by small companies as economic and political stabilisers (Rothwell, 1984; Acs and Audretsch, 1990a; Pratten, 1991), or as sources of important innovative activities (Rothwell and Zegveld, 1982; Archibugi *et al.*, 1991; Archibugi *et al.*, 1999; North and Smallbone, 2000; Tether *et al.*, 1997; Tether, 1998), as well as studies on industrial networks (Håkanson and Snehota, 1995; Pyke *et al.*, 1991) need to be reconsidered. At this point in time, the role of suppliers/subcontractors (and the new industrial structures that this process creates) has gained first priority in the research on industrial dynamics and economic development. For some, the vertical disintegration process ought to be increasingly viewed with some concern. These types of dynamic networks, as pointed out by Teece "…may not so much reflect innovative organizational forms as the disassembly of the modern corporation because of deterioration in national capacities, in manufacturing particularly, that are complementary to technological innovation".[12] Therefore, looking only at the patterns of specialisation and at the process of agglomeration of industrial firms may be misleading, if the processes responsible of the

[10] OECD, 1996. See also Pine, 1993; Pine *et al.*, 1993; Kotha, 1996.
[11] The study by Kearney, 1993, on the sourcing policy in 1000 European transnational corporations is enlightening on this trend. See also the examples in Christensen P. R., 1999.
[12] Teece, 1988, p. 215.

internal dynamics of the systems of firms are not taken into account. By looking at the way industrial systems and networks of industries are internally organised and react to the external environment, light can be shed on the way certain structures are more dynamic than others, on the way local small suppliers withstand the internationalisation of economic activities, and on the reasons for specialising or de-specialising in certain operations.

From a political economy point of view, the central issue is how a national economy can benefit from the participation to the international division of labour given a certain industrial structure and a given specialisation in high or low technology sectors. The advantage of Bennett Harrison's approach lies in the shift of focus from the type of specialisation to the type of power structures regulating the industrial systems. It represents a method for analysing the processes at the base of the industrial restructuring, though the complexity of these phenomena requires also the use of other models of interpretation. It also puts a new question mark on the role of small and medium-sized enterprises in the process of development, i.e. whether they are the cornerstone of a new form of industrial organisation or whether they are increasingly squeezed by the processes outlined and doomed to play the role of buffer for large firms.

2.2. The emergence of the relational firm

Complementary to the view on the process of "concentration without centralisation" is the discussion of the "relational firm" which has emerged in recent years (Belussi *et al.*, 1998; Garud 1994; Afuah, 2000, Gulati, 1998, Gulati and Singh, 1998). This approach is based on the fact that firms are increasingly interested in searching the needed complementary competencies outside their boundaries instead of developing them in-house.

In fact, firms are paying greater attention to the establishment of strategic alliances and collaborations with other firms, building up heavy "network architecture". As Lorenzoni and Lipparini state, "a firm's network portfolio becomes a key organizational attribute".[13] This is done with the aim of "recognizing dysfunctional routines, and preventing strategic blindspots",[14] but also with the aim of acquiring the capabilities needed to fill the gap between the firms' "knowledge domain" and "product domain" (Grant, 1996a). According to this view, the ability of the firm to remain in the high value markets depends on its ability to create strategic interdependencies with other firms in the same market (Garud, 1994; Normann and Ramirez, 1994). This process should induce a process of learning that will be able to mitigate the costs of the general restructuring of the industrial sector.

These contributions have the merit of underling that: a) the performance of the network, in the sense of growth and value of its output, does not depend only on the type of sector or size of firms involved; b) that networks' variety is very large, and c) that the output of inter-firms collaborations depends largely on the combination of internal and external factors with the network architecture. Therefore, even networks such as, for example, those among low and medium low technology producers in which R&D investments are lower, should be able to develop new knowledge and innovation leading to a competitive advantage (see for example Sterlacchini, 1999). For Belussi this means that "[firms]...thus have strategic reasons to prefer redundancy to leanness, in contrast to (the until recently) fashionable issue of the lean firm, which has become so popular in business manuals".[15]

[13] Lorenzoni and Lipparini, 1999, p. 331.
[14] Teece and Pisano, 1994, p. 545.
[15] Belussi *et al.,* p. 416.

The implications of this process are manifold. On the one hand, the fact that firms are increasingly investing in their relational architecture is making the management of the innovations a complex and increasingly reflexive process (Sundbo and Fuglsang, 2002). Internal and external networks create complex webs of relationships. Firms have to evaluate and monitor these accurately otherwise they will be excluded from the market. At the same time, the possibility to "reflect" over the opportunities offered by the market depends largely on the relational position the firm can establish within the network, i.e. on its power to influence other firms' activities. On the other hand, the need to create external networks re-proposes, in a revisited version, the internal problems of governance and redundancy of the individual transnational firm (Zanfei, 2000). Accordingly, firms need resources to invest co-operatively in the creation of new internal knowledge and the acquisition of external knowledge. This process differs, largely, across sectors. In sectors in which investments in R&D are the driving force behind innovation, the network-related sunk-cost will be balanced by the sharing of the total cost of common investments in new technologies and outweighed by gains provided by (expected) positive externalities.[16] It is also believed that a "sharing attitude" towards investments is probably higher in very dynamic networks in which trust among members is very developed, and lower in loosely connected or very hierarchical networks.[17] Although, it has been demonstrated that a "sharing attitude" does not necessarily leads to a better performance.[18]

[16] Belussi *et al*., p. 416.
[17] And although investments' sharing is possible only in specific types of networks and sectors, it cannot be excluded that cooperation and co-development of capabilities may take place in other networks and sectors as well.
[18] Even the most dynamic networks, those in which large and small high-tech firms collaborate, cannot be the most efficient. In the case of, for example, the Silicon Valley, the rewards from the innovation produced could not be captured and the chip industry lost considerable ground to Japanese firms during

At first sight, the creation of heavy relational architecture is contradicting the concentration without centralisation process. Instead, I believe that both of them imply a de-centralised and de-verticalised mode of production. In Belussi's approach, firms establish complex networks to find outside the needed competencies. Redundancy concerns disembedded knowledge, and not capital investments. The firm is born already "lean". In Harrison's approach firms undertake a dis-integration in order to reduce market risks and heavy investments in machinery. However, Harrison's concentration without centralisation approach also implies a complex structure of relationship. The substantial difference lies in the fact that while Harrison's power structures are taken for granted in creating new form of dualism, in Belussi's approach firms are part of a complex architecture with a multitude of relationships in which different power structures are unfolded each time. The benefit of the relational firm approach lies in the fact that it explains how the creation of network architecture takes place. Different types of learning are responsible for different power structures and therefore a newly established ground for policy makers concerned with local development is born. However, in both approaches it still unclear how the network architecture and how the unfolding of the power relationships affect the process of innovation, and hence the competitiveness of a production systems. In the following section, an attempt to synthesise the approaches presented is carried out in order to identify the "missing link" for the understanding of the dynamic of industrial systems.

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the 1980s (Hobday, 1996, p. 157). Even if in the 1990s the situation reversed, the industry observers spoke of a general recover of the electronic industry in which large firms, such as Motorola, Intel and AMD played a substantial role, and not networks as such. This type of network is thus good for the introduction of innovation in the markets, and for the innovator the benefits of such inventions can bare heavy fruits, but is not good for exploiting the benefits connected to large markets, such as the electronic industry.

3. Towards a new approach: The "Structural dynamism" of business networks

Studies on systems of firms have provided different definitions of inter-firms collaborations or networks. The concept has been applied to the user-producer relationship (Lundvall, 1992); the industrial district (Pyke, Becattini and Sengenberger, 1990; Sengenberger, 1989; Piore and Sabel, 1984; Becattini 1998); the high technology clusters of industry (Storper, 1997; Saxenian, 1991 and 1994; Hobday, 1996; Keeble and Wilkinson, 1999); the association of suppliers (Christensen and Dalgaard, 2000; Crone and Watts, 2000). To different extents, most of them have taken as their starting point the fact that firms located in territorially bounded networks, and benefiting from a system of co-operation and competition, sustained by local institutions, are necessarily innovative and dynamic.[19]

From my point of view, what is mystifying in the studies on 'systems of industries' is that most of the emphasis is put on the role of geographical proximity and localised learning, and little attention is given on the overall implication of being part of a network and on the fact that networks are not given and isolated structures. Even if geographical proximity is certainly an important spur to face-to-face interaction,[20] the system's functioning depends upon other factors as well. It is therefore important to introduce a perspective considering that the sustaining of competitive advantages of

[19] For this study, a network is defined as "a set of vertical and horizontal inter-firms relationships that each firm considers relevant for its productive function and which reduces static and dynamic uncertainty". More simply, the term can refer to "two or more organizations involved in long-term relationships, which due to the intensity of their interaction constitute a subset of one or several market", as in Thorelli, 1995, pp. 229-230.

[20] As demonstrated for example in the contributions published in the Cambridge Journal of Economics Special Issue on Learning, Proximity and Industrial Performance, Vol. 23, N. 2, March 1999. Cf. in particular the introductory article by Amin and Wilkinson, 1999.

firms, and of the regions hosting them, depends instead on the combination of a set of factors ranging from the international dynamic of the industries to the single firms' management strategy, passing through the type of relationships within the network (and especially the role of the hierarchies within it). Consequently, the analysis should not only limit itself to the definition and description of the macro, meso and micro levels but, mostly, to study the interactions occurring between them.

The "structural dynamism approach" developed in this study will provide the general framework for analysing the processes of knowledge development and innovation at the level of the single firm. Then, it will examine the effects of this development on the governance structure of the network, and its effect on the learning trajectories. The advantage of this approach is that it may be applied to the analysis of any type of production system, eliminating the influence of factors such as geographical proximity or firms' size, that have received too much attention in the studies on industrial dynamics and local development.

In a situation where production chains are increasingly internationalised (Gereffi and Korzeniewicz, 1994; Gereffi and Kaplinsky, 2001; Lazonick, 1993) attention is to be paid not only to the type of interdependencies that firms are establishing with each other, such as described in Håkansson and Svehota (1995), but to the effects of these linkages on the other firms in the network and on those located in the same territory.[21] In this approach markets are considered the independent variable, while learning processes and power structures are the dependent variable of the model. For example, networks' growth or decline cannot be

[21] This last point has been criticised by Krugman on the base that while internally the implication of participating to certain market networks instead of other are reflected in the overall performance of the firm, the external implications are more difficult to identify and especially to measure. Some defined them "invisible" externalities. See Krugman for example in Martin and Sunley, 1996.

treated separately from the international markets dynamic. By the same token, the type of governance of a network is a necessary but not sufficient explanation for understanding the performance of firms. Similarly, the type of learning occurring among firms is more important to capture the benefit stemming from innovation than the size and technological level of the firms.

The thesis will look at the crucial research issues of how networks' structural dynamism affects the single firms and how the development of the single firm's internal resources affects the networks' dynamic, in a given market (which in turn has its own dynamic independent from the others). This view places the role of knowledge development and learning at the centre of the process of reinforcing the firm's relational position within the network. It looks at both the way the change in the power structures affects the learning capability of the firm (and its innovative capacity), and the way the development of new competencies affects the power structures. By focusing on the ability of small firms specialised in products considered as low and medium-low technology and supplying large and internationalised companies,[22] to enter and remain in the network of suppliers the thesis will attempt to demonstrate how the structural dynamism of the system is responsible of the processes. The study has also important implications from a policy perspective, since it implies a general re-consideration of industrial and innovation policies that have been based either on a static perception of industrial structures, or that limited the analysis to the quantitative output of the inter-firms collaborations, or that

[22] According to the OECD, 1996, an industry is classified as high, medium and low technology depending on the aggregate R&D expenditures. Less than 1% is low, between 1 and 3 is medium and over 3% is high technology.

focused on a specific industry (see for example Huggins, 2001; Bianchi and Bellini, 1991).

The advantage of the "structural dynamism" approach compared to the "relational firm" and the "concentration without centralisation" approaches lies in the ability to connect the different elements (learning, governance and markets) that are responsible of the process of innovation. In this way, the variables at hand are three, of which one (the market) is independent from the others. In fact, if the "relational firm" approach can explain the creation of the governance and the "concentration without centralisation" the dynamic of the process of learning in different type of hierarchies, only by including the markets' dynamic it will be possible to explain how the structures and the processes change.

4. Defining the research objectives, strategy and problems

This study is about how small firms supplying large and internationalised firms are surviving industrial restructuring, remaining or gaining a better position in the high value markets. The main aim is to identify the mechanisms, the processes and their outcomes that enable firms to improve their 'relational' position within the network. Next, to find out whether these processes of change are facilitated by or hinder the innovation capability of other firms. This analysis will also contribute to highlight how different forms of governance can lead to a better distribution of the benefits stemming from innovative activities.

4.1. The field and object of study

The study looks at the ways small low-tech companies actively react or undergo collaboration with large and internationalised companies, and in particular at the outcomes of this relationship. The main objective of the research is to analyse *how* small firms cope with the process of industrial restructuring, focusing in particular on the way they engage and develop innovations interacting with other firms or markets.[23] The thesis aims to identify both the tangible and intangible inputs, obtained both inside and outside the sphere of market transactions, and produced through the interactions between firms, that allow firms to gain a better relational position. This means highlighting the firms' capability to develop and acquire such elements (i.e. the learning capability) and to identify the mechanisms that can be used to influence the learning trajectory of a production system. This has complex methodological implications, due to the difficulties in the measurement of competencies, power structures and innovations. In the specific case of innovative activities, already ten years ago Archibugi stressed that a distinction should be made between the "object-based" approach, in which the focus is on the identification of innovation themselves and their measurement, and the "subject-based" approach, which instead starts by asking the firms about their innovations (Archibugi, 1991).

This study follows a "subject-based" approach for two main reasons. Firstly, because the output of small firms innovative activities, and especially of those in the low technology sectors, is more difficult to quantify than in large firms where indicators such as patents, R&D

[23] In the following pages, the concept of innovation is used to indicate the outcome of the use of new or existing knowledge in a new application, such as for example a new process technology or a new product. This definition has the advantage to enlarge the spectrum of innovation to those operations that are more difficult to identify such as the modification in the design of the products.

expenditures per employee, etc., are available though not always enough to show the innovativeness of a firm. Secondly, because it is assumed that a more qualitative and in-depth method is needed to identify the sources of innovation and the dynamic of the related learning processes.

Indeed, as demonstrated by the existing literature on the subject, when dealing with small firms in low-technology sectors emphasis should be put on the incremental innovations encompassing sometimes only slight modifications of products' design or process technology, but which are nevertheless very important for the firm and the industry as a whole. The hidden process of innovation in small firms is explained by the fact that the main source of innovative activities is the tacit and unquantifyable knowledge, which continuous development is the sole responsible of the creation of the firm specific assets (Teece, 1998).

From a geographical point of view, the research is limited to the interactions between firms and their suppliers located in Denmark. This is explained both by the practical reason of being physically at the location, and on the ground that the Danish industrial structure presents a manufacturing sector in which there is a majority of small firms producing for the local market. Furthermore, on the one hand the Danish context is not diverse in terms of specialisation of the manufacturing sector from other small OECD-countries, which may allow for generalisation. On the other, the share of employment in firm with fewer than hundred employees is about 7 per cent above EU-level, while the share of employment in firms with more than 500 employees is 13 per cent below EU-level,[24] which justifies the focus on the role of smaller enterprises in the process of international industrial restructuring.

[24] Figures taken from Danish Industry, http://di.dk/english.

These preliminary considerations are made to stress that in analysing innovation, different contexts imply different perspectives, different methodological tools of analysis and give rise to different research problems, and hence, there is the need to "contextualise" the research problem from the outset, though briefly. A more articulated description of the Danish industrial sector dynamic and structures is provided in chapter three.

4.2. The Danish context

Denmark has one of the highest GDPs per capita, one of the lowest OECD countries' unemployment rates, a constant growth in GDP and industrial value added. These achievements were possible despite the presence of an industrial sector highly specialised in low and medium low technology sectors, and with 94.5 per cent of the enterprises having fewer than 100 employees. Despite a decrease in the share of total employment, from 18.6 in 1990 to 17.7 in 1998, sales of commodities and services by manufacturers have increased by 21 per cent in the same years. Exports of manufactured products have also increased from 72.5 to 77.5 per cent of total exports. In the same period, imports of intermediate goods for other non-agricultural industries decreased from 37.3 to 35.6 per cent.[25] Industrial production in Denmark is not ready to disappear, and it still represents an important stronghold of the national economy. However, how the increase in productivity shown by the statistics can be related to factors such as innovation and flexibility, and if these are developed relying mostly on local capabilities and resources of single firms or networks is not clear

[25] Denmark Statistics, 1999.

yet. Likewise, how this pattern of specialisation can be sustained in the long run is also an open question.

Finally, there is another peculiarity of the Danish industry that needs to be underlined, and that is relevant for this study. The presence of multinational corporations in the low-tech sector, despite the small size of the market, a location on the outskirts of Europe, and the fact that the incidence of nominal barriers to trade is not a factor that makes a difference compared to other EU countries. This is an important element in the structural dynamism of the local production systems due to the fact that it introduces an international dimension into the processes of knowledge development and learning.

4.3. Formalising the problem

The arguments presented are questioning whether the emergence of new forms of industrial organisation are hindering or favouring small enterprises, and how small enterprises can cope with this process. This is the main question that the study attempts to answer. From this perspective, it is assumed that the creation and diffusion of knowledge useful to the economy determine the power structures of a network/production system that in turn govern the processes of learning and innovation. Therefore, in relation to the general problem, three sub-questions can be raised:

1. Why and how do some small firms remain in the network of suppliers while others disappear?
2. How do past and new governance structures characterising a network affect the processes of learning and innovation?
3. Does innovation play a central role in firm's success?

This research is based on the general assumption that a firm is not isolated but is part of a *production system*, which dynamic should be responsible for the processes that improve or decrease the possibility of success for the individual firm (and for the geographical space in which is located).

4.4. The research hypotheses

The considerations and argumentation presented so far enable the formulation of the hypotheses that lay behind the research strategy. The main hypotheses to be tested by the analysis are the following:

- The role and position of small firms in the production system are not necessarily affected by the size and sector of activity;
- The ability of a small firm to remain in the high value markets depend upon its ability to develop economically useful knowledge;
- The possibility to develop firms' competencies and resources depends upon the position in the network;
- The more hierarchical the network, the more dependency is created and the less capabilities are developed;
- The quality and not the quantity of the flow of knowledge that will supposedly be absorbed and integrated by network members is relevant for the creation of strategic capabilities;
- The internal resources of the firm (human, knowledge and technology) are not always adaptable to the network's needs, or maybe just not enough to undertake some specific collaborations or networks.

The individual firm needs some time to adapt its own competencies without undergoing a crisis. A "crisis" in one of the "spokes" or "nodes" of the network can have repercussions on the whole system. In fact, as claimed by Teece and Pisano (1994) and Ruigrok and von Tulder (1995) it is not possible to change one level of the system without changing others due to the high interdependency existing within and between production systems.[26] Thereby, the learning dynamic of the individual firm cannot be separated from the learning dynamic of the production system in which the firm is located and from the dynamic of its markets.

Following this approach, the research can provide a new way to analyse the source of advantage at the base of the success of the Danish manufacturing sectors, and can shed light on the bottlenecks and disadvantages small firms face with the challenge of globalisation. This means to go beyond a dyadic analysis of user-producer relationship, and undertake an analysis of the properties behind the process of learning, its sustainability and the sustainability of the new forms of industrial organisations for the host country/region.

5. The outline of the thesis

The thesis is divided into six chapters. In the next chapter the conceptual framework for analysing power structures' influence on learning and innovation in industrial production systems will be outlined. This chapter will attempt to develop a 'language' and a 'syntax' that will enable the analysis to be carried out. Chapter three looks at the Danish industrial structure and the dynamic of the industries of the firms in the selected

[26] Teece and Pisano, 1994, p. 543. Ruigrok and von Tulder, 1995, p. 36.

production systems from the perspective of the restructuring process. This represents the macro level of the thesis that will enable to put the study of the dynamic of firms and networks in a more general context. Chapter four will present the general characteristics of the production systems selected for the analysis, dis-aggregating them at the level of the single units (i.e. firms or network's nodes) and presenting the firms' histories and activities. It is a descriptive chapter aiming to provide detailed information about the activities, history and specialisation of the firms in the production systems. In Chapter five the effects of a modification in the governance structure on the small firms will be analysed. This will aim to identify the existing power structures and their influence on the creation of new knowledge in the individual firm, and the influence of new knowledge on the power structures. In this chapter the process of creation of networks' capabilities from the single firm capabilities, their upgrading and downgrading, will be analysed, trying to highlight the importance of the redistribution of the benefits stemming from innovative activities. In the final chapter, the academic debate concerning the resources of the firm, the process of learning and the economics of networks will be revisited and discussed in the light of the "structural dynamism approach". This will represent the base for the development of an approach to network and learning that enables to link the dynamic at the level of the firms with that at the level of the production systems and of the markets. In the following section, the methodological issues related with the approach discussed in this introductory chapter are discussed.

6. Learning and governance in industrial networks: Some methodological considerations

The study was inductive in nature and is based on case-study research. As stressed by Eisenhardt, "case studies can be used to accomplish various aims: to provide description, test theory, or generate theory".[27] The nature of this study is both descriptive, due to the use of empirical material, and theory building trying to develop a new conceptual framework for the analysis of industrial networks and innovation.

The research entails different levels of analysis: the single production unit (the micro level), the production system (the meso level), and the sectoral dynamics (the macro level). The starting level is the production system. Multiple cases will be used, and comparisons between the different production systems will be made. Each case is analysed looking at its components, i.e. the production units. That is to say that each case includes "mini-cases". Since the research aims to analyse the process of resources creation, learning and innovation in production systems, and since each firm is the repository of the resources that are developed into resources of the production system, a systematic description of the firms' activities and core-competencies will be included. The unit of analysis remains the production system, but with its sub-units in the firms. To this picture will be added an analysis of the dynamic of the sectors in which the firms operate, and a general description of the industrial context. Knowledge creation and firms' dynamics cannot be analysed without taking into account the local and international dynamics of the markets in which knowledge and information are generated. Furthermore, to avoid ending in a blind alley as a result of never finding a limit to the set of relationships

[27] Eisenhardt, 1989, p. 535.

governing a production system, the field-study was limited to a small number of actors and of relationships. At the same time, the research focused on the effects of the process of industrial restructuring described in chapter one only on one type of firm. Due to their prominence and importance for the Danish and European economy, the choice was of small firms supplying large internationalised enterprises.

The choice of case study research is also based on the pretension to generate new theory (Glaser and Strauss 1970). The hypothesis to be tested can indeed shed new light in the understanding of the process of learning and innovation in systems of enterprises. Therefore, the sampling of the cases was made for theoretical reasons, since they include different categories and types from which it will be possible to generalise. As pointed out by Pettigrew in Eisenhardt (1989), "given the limited number of cases, which can usually be studied, it makes sense to choose cases such as extreme situations and polar types in which the process of interest is 'transparently observable'. Thus, the goal of theoretical sampling is to choose cases which are likely to replicate or extend the emergent theory."[28] This method is also useful for a research design as the one at hand, in which there are multiple cases and multiple levels of analysis within the single study, such as for example when both industry and firm are studied contemporarily.

Another issue, often underlined by qualitative researchers, is the problem that in the process of theory building from case studies there is frequently an overlap between data analysis and collection. However, this is seen as an advantage because it allows "the freedom to make adjustments during the data collection process. These adjustments can be the addition of

[28] Eisenhardt, 1989, p. 537.

cases to probe particular themes which emerge".[29] This "licence" for the researcher is justified by the fact that in this type of research, the alterations are possible because the aim is "…to understand each case individually and in as much depth as possible. The goal is not to produce summary statistics about a set of observations. Thus, if a new data collection opportunity arises or if a new line of thinking emerges during the research, it makes sense to take advantage by altering data collection, if such an alteration is likely to better ground the theory or to provide new theoretical insight. Rather, this inflexibility is controlled opportunism in which researchers take advantage of the uniqueness of a specific case and the emergence of new themes to improve resultant theory".[30]

6.1. The rationale behind the selection of the cases

Three different cases of production systems have been selected (PS. No. 1 to 3) for the analysis. The firms belong to different industrial branch classifications. For the first and the second, the output of both customers and suppliers is classified, according to the OECD,[31] as low and medium-low technology (food and packaging), while the consumer good producer of the third production system is in the high-tech (pharmaceutical) and the suppliers in the low and medium-low technology industries (packaging). The production systems are described in chapter four. The description is central to the generation of insights because it helps to become familiar with each case as a stand-alone entity. In this way, the unique patterns of each case are pulled to the surface, and then through the comparisons with the other cases generalisation can be drawn. After the description and the

[29] *Ibid.*, p. 539.
[30] *Ibid.*, p. 539.
[31] OECD, 1996.

analysis of each mini-case from within, the cases have been compared with each other in order to search for patterns of information, and avoid (limit) the reach of premature conclusions as a result of the information-processing biases that notoriously affect the researcher. This analysis is presented in chapter five.

In the analysis the dimensions chosen are the size-effect, the technological level of the supplier and of the contractor, the market trends and the governance structures, so as to look for within-group similarities coupled with inter-group differences, which should allow the emergence of patterns. Then the cases are compared with the aim to make the subtle similarities and differences between them more visible.

The sources of information used were both the Greens and the Kraks firms' directories. The small firms in the three production systems were selected on the base of two principles. The first principle was to select an internationalised Danish large firm and then reconstruct the network of specialised suppliers. The second was to select a small supplier of packaging and then go back to the large company and on to the other small suppliers. In both cases the firms were selected according to:

- *Size*: The large ones were considered those with more than 250 employees; the small ones those with less then 100 employees, which in Denmark represent the biggest class of firms and the SMEs sector;
- *Markets*: The connection to international markets, only for the large firms;
- *Technology*: The low-technological content of the product according to the OECD classification, only for the small firms. The large firms selected are in the low and medium-low-tech sectors as well, with the exception of the pharmaceutical industry in the PS No. 3.

Table 1 - Sample of selected firms

PRODUCTION SYSTEMS	FIRMS
Production System #1	Toms (Confectionery) Schmidt, WP, Schur (Folded Carton Packaging) Polyprint (Flexible Packaging)
Production System #2	ARLA-MD Foods (Dairies) Rynkeby (Juice) Schela (Plastic bottles) SCA, SMURFIT (Transport Packaging) TETRAPAK, ELOPAK (folded carton packaging) Novaprint, Seglemærkfabrik (Labels)
Production System #3	Lundbeck, Novo Nordisk (Pharmaceutical) Medigrafik (Folded Carton Packaging) Cerbo (Plastic Packaging) Polack (Leaflets)

The industries of the core firm of the production systems analysed represent important strongholds of the Danish economy. Restructuring and international competition in these sectors are particularly strong. The small firms selected for the surveys are in the packaging sector. As mentioned above, the choice to limit the sample to this sector was due to the fact that raw material and equipment of the core firm are generally bought either on stock markets or through intermediaries. Packaging is a sector that is less affected by international competition and in which proximity with the core firm should be still important (Hansen and Serin, 1997). Still, the transformation of the upstream industries also affects the packaging firms. Furthermore, this sector is undergoing major changes following the introduction of new materials, such as flexible packaging in the food industry and plastic in the pharmaceutical sector. The focus on these firms is therefore representative of a trend in the OECD countries in which low-technology small firms (which represent the majority of industrial establishment and an important source of employment) are put under an

increasing pressure from innovation within the sector and from the restructuring in the related sectors. [32]

6.2. Data Collection

A letter on green paper (in order to draw the attention of the potential interviewee) asking for an interview and explaining the rationale of the project was mailed to the sales and purchasing managers of the firms selected. Then, the firms that accepted to participate were visited and the manager interviewed. Data were collected between 1999 and 2001.

The interviews followed a prepared list of 12 open-ended questions and lasted between 1½ and 2 hours. The interviews were followed by a visit to the company production plant that presented the opportunity to see the production process, and ask the informant specific questions about the plant production technology and organization. To this, other sources of information were added, such as visits to the Internet home page of the company, books and brochures about the company history, activities and partnerships. In some cases a "following-up" interview was done in 2002 to verify the effects of the modification of the governance structure. However, due to the limited resources not all the production systems were double-checked.

[32] A recent study by the OECD (1996) states that, "The global expansion of industry has more general implications for small and medium-sized firms operating in internationally trading industries even if they have no international operation themselves. They are major suppliers to large firms, and there are rising competitive pressures on large firms to increase efficiency and purchase more goods, intermediates and services inputs externally. This provides opportunities for small firms to form subcontracting and supply linkages into large ones. But, these linkages are increasingly driven by international strategies, and local small firms face competition in supply from small firms in other countries, and from larger specialised international suppliers with internal R&D capabilities which smaller firms lack".

6.3. Network structure

The interviews with the managers of both the large companies and the small suppliers enabled to reconstruct, although only partially, the "nodes" represented by each firm of the network.[33] This was done identifying the "centre" of the network and then, starting from there, localise the "rings". Therefore, when the starting point, that is to say the first interviewed, was a large and internationalised firm, the problem emerged immediately of whether the firm in question was a "centre" of a network, or if it was a large ring of another network. If this turned out to be case, the case was dropped since the focus is on the small suppliers. If the starting point was a small supplier, then, it was easier to find the "centre" and from there identify the other suppliers to be interviewed. The definition of centre and ring will be better explained in the analytical framework.

However, a network is not an isolated group of rings and centres linked in a business relationship. As stated by Knoke (2001), the internal structure of the network cannot be fully understood if the external environment is not taken into account. In his approach to network, Knoke points out that the internal and external structures of the network are represented by a set of ten conceptually distinct dimensions (or sectors): 1) Industrial sectors; 2) Market sector; 3) Raw materials; 4) International; 5) Government; 6) Sociocultural; 7) Economic conditions; 8) Technology; 9) Financial resources; 10) Human resources.[34]

The first, second and fourth dimensions will be discussed in chapter three, where the dynamic of the industries that are represented in the chain of each production system will be presented. In this chapter a brief reference will be also done to the fifth, sixth and seventh dimensions of the

[33] I say 'partially' because each firm is embedded in its own constellation of relationships that is difficult to reconstruct entirely.

external environment. These represent the macro levels of the analysis. The third, eight, ninth and tenth dimensions will be discussed in chapter four where the production systems are presented. These represent the micro dimension of the analysis. The complex intertwining between the external factors with the internal factors is the "political economy" of the production system. Each of these elements has an impact on the structure of the network and hence on its outcome.

7. Measuring knowledge development in firms and networks

Assuming that one of the sources of power in industrial networks is the availability of specific assets (see chapter two for the discussion) and that this is the result of an accumulation of certain skills and competences, then the introduction of new products or processes, or their incremental modification, is the tangible result of the development of these skills and competences. Innovation is thus the proxy of this development. However, the measurement of innovative activities has been always a "thorn in the eye" of industrial and organisation economists.

As stated by Evangelista *et al.* (1997), surveys on the "innovative phenomenon" have followed two main approaches:[35]

- One collecting information on the innovation introduced, such as in the surveys conducted by Pavitt 1984; Acs and Audretsch, 1990b;

[34] Knoke, 2001, p. 6.
[35] Evangelista *et al.*, 1997, p. 523.

- The other questioning firms about input, output and the nature of the innovative process, such as those in Scholz, 1992; Kleinekecht and Reijnen, 1991; Archibugi *et al*. 1991; Cesaratto *et al*. 1991.

In either case the main problem laid in the impossibility of comparing the statistical data across countries and over time, despite the attempt of the OECD Oslo Manual and the EU Community Innovation Survey questionnaires. The improvement and development of the different approaches have also followed the development in the intellectual framework at the base of the measurement activity. Thus, while the output is still related to Schumpeter's seductive analysis (1934 and 1942) the inputs or sources of innovation include other elements today. In particular, the recent attention given to the "innovative phenomenon" as an interactive learning process, involving several actors has led to the inclusion in the sources of innovation less quantifiable variables such as skills, capabilities, competencies, design, and in general localised technical knowledge (Antonelli 1999a and 1999b), embodied not only in the machinery but also in the workers and managers. Since R&D expenditures, patents and capital investments can provide only a part of the explanation, new conceptual tools and methods are required to identify the "innovative phenomenon".

Furthermore, the traditional approach to innovation measurement has also demonstrated that the nature and results of the process change across sectors, organisation size and techno-economic and institutional structures in which the productive system is embedded.

In the present study, the "innovative phenomenon" is considered as a main factor of survival and advantage of the small firms, as well as the outcome of a learning process in which many elements, internal and external to the firms, contribute. However, central to this study is that

innovation *per se* cannot represent an advantage if it is not sustainable with the resources of the firm, and with the resources of the production system and of the territory in which they are hosted. For this purpose the thesis resorts to the notions of systemic and autonomous innovation (Teece, 1986). Systemic innovation implies that a change in one of the nodes –i.e. the firms- of the system will affect ineluctably the other actors with consequences often unknown. Therefore, innovation can either upgrade the overall performance of the network or just of one of its components. In the former case the knowledge developed is redistributed, while in the latter case it may hinder the productive structure of a country/region through the disappearance of firms and the consequent loss of knowledge basis. This study will focus on the innovative activities in order to identify knowledge development and creation, according to the theoretical constructs in chapter two, and it will look at their dynamic in order to identify the consequences of a change in the assets of a firm for the learning processes.

8. Conclusions

This first chapter has provided the justification and the rationale for the formulation of the research questions, and the method that will be used to carry out the study. It has also introduced the discussion on the current trends within the literature on industrial dynamic that are setting the conceptual agenda to explain the consequences of this relatively new wave of restructuring of the industrial production worldwide. However, as it has pointed out, the new reality and challenges that the industrial sectors, and particularly small firms are facing require new perspectives and tools of analysis to be fully understood. Therefore, it has been introduced a new approach to the study of industrial dynamics. The "structural dynamism"

approach to the study of production systems has the advantage to introduce the market dynamic in the analysis of industrial innovation not as a stand alone entity but in connection to the forms of governance and the different types of learning that take place in a production system. By taking into account the macro trends in the sectors studied and the micro dynamic of individual firms, the study has the aim to understand the dynamic of production systems (the meso level). The analysis of three different production systems, representative of the different forms of governance identified in the analytical frame, will contribute to the understanding of the role of smaller firms in today's industry. The analytical framework that will allow for this type of analysis is discussed in the following chapter.

CHAPTER TWO

Resources, Forms of Governance, and Innovation in Industrial Networks

1. Introduction

The recent attention given to networking and strategic interdependencies between independent firms has had both intellectual and methodological implications for the study of industrial systems.

From a methodological point of view, this has put an end to the methodological individualism, "the firm as unit of analysis", that characterised the strategic management literature of the 1990s and put more emphasis on the dynamic of "systems of firms". A visible consequence of this is the passage from a static vision of "industrial structures" and "firms' resources", towards a more dynamic and qualitative analysis of the interactions between firms (Lundvall and Johnson, 1994). Thus, more careful attention to the way interdependencies between firms are established, the modalities through which the learning processes take place, and the way the resources of the firms co-evolve and co-develop, is given in the analysis of industrial networks (Guerrieri, Iammarino and Pietrobelli, 2001).

From an intellectual point of view, the networking and strategic interdependencies perspectives have challenged the traditional view on the "make or buy" dilemma, at the base of Williamson transaction costs economics, to the more general problem of resource development. Therefore, reducing the problem of transaction cost to only one type of

transaction, i.e., the acquisition of the knowledge necessary to fill in the gap between what the firm 'knows' and what needs to know in order to produce a given good (Grant 1996a).

In the present work, the choice to study business networks from a systemic perspective is motivated by the fact that even the resource-based and the knowledge-based approaches suffer from "methodological individualism", i.e. "dynamic capability development", and lacks a clear explanation of the factors at the base of the formation of firms competencies and which of them should be developed (Lazonick, 2002; Eisenhardt and Martin, 2000; Teece *et al.*, 1997).

In studies of innovative firms and innovative networks, the causality between network structures and innovation has always been considered as static. For example, Lipparini and Lorenzoni emphasised that past work has tended to consider networks as given contexts.[36] Indeed, network structure is in a continuous flux, its shape being influenced by the development of certain capability of the single firms, which in turn has implications for the dynamic of the markets. From this perspective, network structures are dependent on the type of learning processes and hence on the dynamic of the process of innovation reshaping the relational positions of each firm.

Therefore, the study will focus on the way resources and competencies in individual firms are mobilised and continuously developed, in order to sustain competition and innovation (Foss, 1998; Nonaka and Takeuchi, 1995; Grant, 1996a and 1996b), but also, on the way firms' resources and capabilities become the resources of the whole production system (Foss, 1999).

[36] Lorenzoni and Lipparini, 1999, p. 318.

It is necessary to stress from the outset that demonstrating the existence and working of the various links, internal and external, characterising each network may recall the myth of Sisyphus, and may raise methodological difficulties. The empirical part of the thesis will in fact take into account only few cases of inter-firms relationships, although observing them thoroughly, through in-depth case study analysis. Similarly, from the very beginning, it is necessary to state that the research draws on the recent contribution in the industrial network approach (Knoke 2001; Harrison and Storper, 1991; Markusen, 1996; Håkansson and Snehota, 1995), the resource-based theory and knowledge-based theory of the firm (Rumelt, 1984; Wernerfelt, 1984; Foss, 1998; Nonaka and Takeuchi, 1995; Nonaka and Konno, 1998; Grant, 1996a and 1996b), and the learning approach (Lundvall 1992; Lundvall, 1996; Lundvall and Johnson 1994), also in an attempt to blend the intellectual merits of these scholars, and fill the holes created by the tendency towards "specialisms" occurred in the last twenty years in social sciences. Despite the difficulties in dealing with different approaches and research traditions and the methodological bottlenecks underlined above, the proposed multi- inter-disciplinary approach will suggest paths for further theoretical development in the field of industrial organisation and innovation economics. In order to achieve this goal, it is necessary to develop a language to describe the structures of different production systems. This will later enable us to understand the forms of governance and their internal power structures, and therefore to put a boundary to the cases and allow for comparisons. Following Wilkinson (1983), "The way the production system has being conceptualised make the application perfectly general and provides the basis for analysis at any level (the family, production units, firms, industrial districts, industries, regions, economies, or the world) where the boundaries

are drawn depends on the problem in hand".[37] Then, the concepts used to explain the forces behind the dynamic of the system, and its sources of advantages are discussed in the light of the most recent development of the intellectual debate on the subject.

The chapter is organised as follows: section two introduces the 'vocabulary' and the 'syntax' that will enable us to define the field of the study. Section three develops a notion of production system, taking into account the role of internal and external economies of scale and scope and the power structures. This will enable us in section four to propose a typology of production systems, highlighting the role of quantitative and qualitative factors in shaping their structure. In this section, several types of production systems are discussed with the aim of identifying the flows of knowledge and the possible learning trajectories that can be established. In section five, the recent developments in the resource-based perspective are discussed, focusing in particular on the role of knowledge as a central asset of firm's competitiveness. This section is also the one in which knowledge development, re-generation, and improvement through a process of conversion of tacit into explicit and vice versa, and within a specific time and space is analysed. Section six focuses instead on the way firms' knowledge become network's knowledge and on the mechanisms at the base of the learning processes within the production systems. Then, the chapter concludes with a section presenting an attempt of synthesis of the approaches discussed introducing the central features of the "structural dynamism approach" to the study of innovation and production systems. This represents the model through which the dynamic of systems of firms is explained and the basis for a *theory of production systems*.

[37] Wilkinson, 1983, p. 421.

2. Defining the 'language'

In the study undertaken there are at least three levels of analysis: the production unit (which we call also firm, having in mind a single-unit firm), the input-output system (the network) and the branch (the industry). According to Harrison and Storper, the *production unit* is a "physically-integrated set of activities occurring at a single location. The *input-output system* or production network is "a collection of activities […involving many production units…] which lead up to the production of a specific marketable output". The *branch of production* is "the statistical aggregate of similar input-output systems".[38] In order to link the micro and meso levels (firms and network) with the macro level of analysis (industrial sector), the production systems' dynamic will be confronted with the dynamic of the branch to which the production units belong (see chapter three).

2.1 Types of inputs-output systems

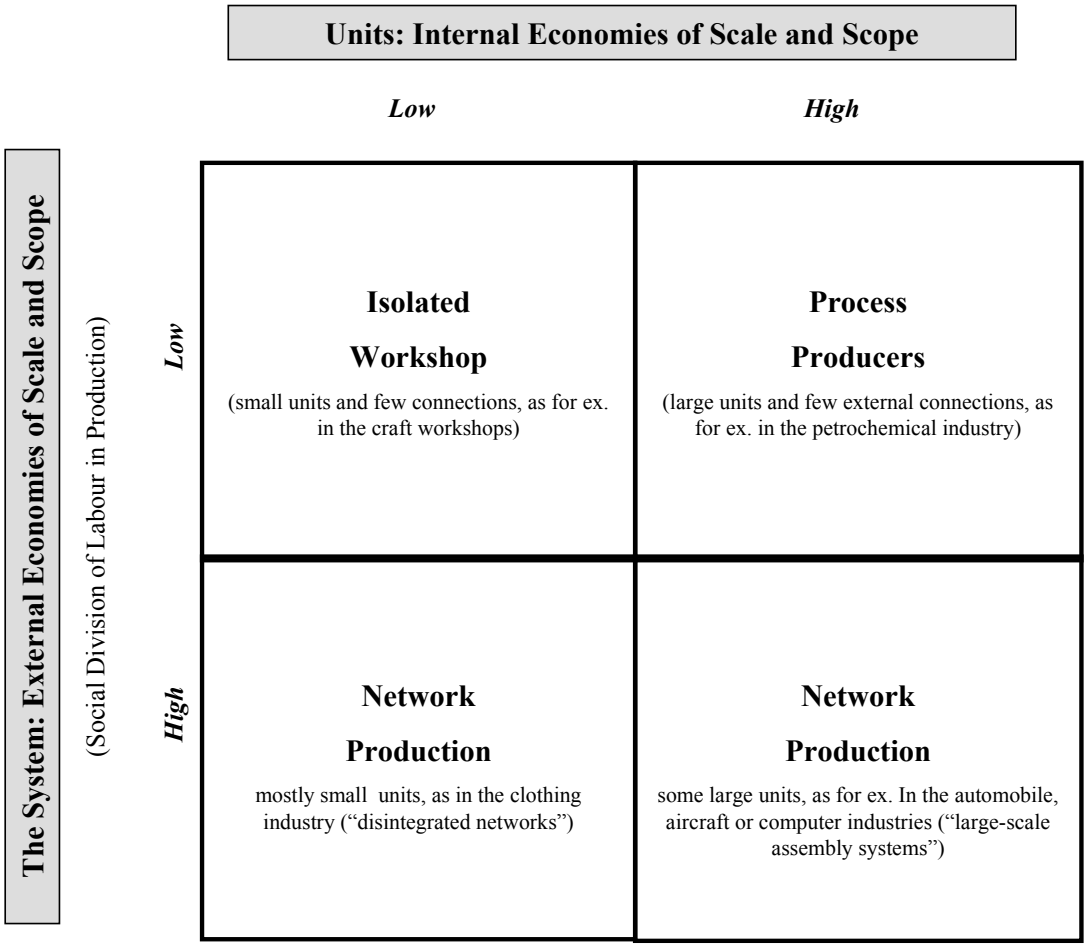
Given the centrality of the input-output systems in the analysis, is important to find a way to systematise them. Following Harrison and Storper, one method is to look at the their internal and external economies of scale and scope (figure 1).

On figure one's horizontal axis the level of "internal economies of scale and scope" are represented. "Internal economies of scale" are found when to an increase in the size or capacity of the production unit or of its inputs there is a more than proportional rise in output, decrease in unit cost,

[38] Harrison and Storper, 1991, p. 408.

or increasing returns on investment.[39] Complementary to these are "internal economies of scope". They exist when the increase in the size of the production unit is due to a diversification of production or more operations of the same production process are performed within the unit. The rise of one or both of them increases the size of the production unit.

Figure 1 - Types of input-output systems



Source: Harrison and Storper, 1991: p. 410.

[39] This can be due to technological indivisibilities between phase of production; to concurrent scale of operations of the different phases in a production process; to coordinative economies; to the sharing of technical know-how and working skills from one process or product to another; or to greater efficiency in social control'. *Idem*, p. 409.

Low internal economies of scale and scope are found in the small craft workshops with a low level of specialisation. This is the case, for example, in isolated micro enterprises in developing countries. High internal economies of scale and scope are in contrast present in the large companies, with high investments on the equipment side that enable large batches and different operations of the production cycle: a good example is what has been often called the "cathedral in the desert".

The systems as a whole, and in particular their internal division of labour, are represented on the vertical axis. Higher division of labour and many small units knitted together are evidence of the presence of "external economies of scale and scope". If the production process is fragmented the individual unit is very specialised, but the system still has a wide scope. This should be the natural consequence of the process of "productive de-centralisation" mentioned in chapter one. External economies of scope stimulate the proliferation of interconnections between production units, and thus the scope of the system as a whole. They overlap economies of scale in the way that they influence the increases of the individual unit scale. It is the case of networks of producers, either independent or part of a large de-centralised assembly line.

In the quadrants of figure 1 are also given some examples of the kind of industries to which each system corresponds. The input-output systems analysed in the thesis are the ones located on the bottom quadrants, in which can be found small firms linked to large firms. In order to understand the dynamism of the structures and their reaction to change of these types of production systems, the qualitative factors at the base of the relationship between firms need to be investigated. In the words of Harrison and Storper: "[…] it is precisely the possibility of adjusting inter-unit relationships that permits changes in output quantity and quality – and

thus enhances adaptability of an input-output system to external shocks and encourages its internal impulses to change, such as product innovation".[40] How these inter-unit relationships are adjusted and how much they depend upon the process of learning and knowledge development is still a black box. In order to open it, it is necessary to introduce in the language we are developing the concepts of *power* and *governance*. Inter-unit relationships have a function governed by some forms of hierarchies and power structures that can facilitate or hinder the process of adaptability of the whole input-output system to a change in the market. It is important to stress from the outset that there is no linear relationship between the power structure, the size and the technological level of the units participating in the input-output system. Instead, the formation of hierarchies and power depends upon other factors, as will be explained in the next section.

Finally, it should be emphasised that in the analysis carried out in the thesis, the territorial configuration of the industrial system, i.e., whether input-output systems are agglomerated within the same country- or are dispersed over regions and countries, is not taken into account. Although the spatial dimension of production is central in the analysis of the regional dynamics, it cannot be understood without first understanding the dynamic of the production systems that each region hosts. Only by understanding the dynamic of the external and internal linkages governing the network can policy makers have bargaining power vis-à-vis the production network and its agents (regardless of the geographical concentration factor). However, it is important to stress that the cases selected for the analysis present the same characteristic of being located within the same country

[40] *Idem*, p. 409-410.

(Denmark) and even the most distant have the possibility to engage in frequent face-to-face interactions.

3. Developing the notion of production systems

To shed light on the internal functioning of the network structure, it is necessary to go a step further in the development of the "language". Networks as input-output systems made of production units (which we call firms), cannot be understood if their "architecture" is not taken into account. The architecture of a network is represented by the organisation in the space of its nodes (the firms), and by the number and type of linkages that link each node. The productive and commercial linkages that constitute a network can be both horizontal and vertical. Horizontally between firms belonging to the same sectors, specialised in similar goods, and competing in the same market; vertically between firms at the top or at the bottom of a products' chain or *filiere*,[41] and linked by sequential work flows.[42] It should be also emphasised that each network firm has linkages with firms that are external to the network. Together with the internal structure, networks thus have a "double-network" structure:[43] internal, between the firms belonging to the input-output system and external between them and the firms of other input-output systems.

[41] A *filiere* is the sequence of operations carried out in the process of transformation of raw material in a finished product. Each filiere is made of productive cycles and each cycle is divided in phases, each phase in operations and each operation in a number of basic movements. The diffusion of flexible mode of production and specialisation has increased the complexity of the filiere. Phases and operations are increasingly distributed among productive units belonging to different sectors' classification, which makes also difficult the identification of the filiere's internal dynamics.

[42] Astley and Fombrun, 1983, p. 205.

[43] The 'double network' structure has been suggested to indicate the TNCs new organisational structure: internal networks are those established within the same company in order to coordinate the internal activity of the firm, whereas external networks are developed with other firms and institutions that are located outside the boundaries of the firm. Zanfei, 2000, p. 516.

To understand the dynamic of the input-output system, the attention should now turn to the organisation of the linkages, i.e. the governance structure defining the type of architecture of the network. The structure of a network is based on the position of each firm in the network architecture. This architecture differs from network to network and is determined by the power structures and hierarchies, which in turn depend upon the stock of resources of the individual firms and the types of learning processes that modify them. This means that in any production systems the type of relationships and governance have nothing to do with firms' size or financial aspects. Rather, it is the presence of both qualitative and quantitative factors that shapes the diverse range of governance structures in production system.[44] The governance defines the nature of the linkages between each node (firm). As Hollingsworth states, "[At] a rather general level, *governance is the process by which activities and conflicts among various actors are coordinated and managed*".[45] This will contribute to the definition of the notion of *production system*.

In the following paragraph, the various types of governance are presented. To each type of governance correspond a different type of production system.

3.1. Power, Hierarchy and Governance

Since the study is concerned with the main issue of power structures and learning within input-output systems, it is now necessary to understand what is meant by power, what are the elements that create power, the type of hierarchy it may establish and the resulting form of governance.

[44] See also Lachman, 1989.
[45] Hollingsworth, 1993, p. 301. Emphasis in the original.

The issue of power in economics finds its origins in the business history literature trying to deal with the emergence of powerful economic organisations, and its effect over the smaller ones (Chandler, 1977; Galbraith, 1967; Reagan, 1963). Today, the increasing complexity of production systems needs another perspective that go beyond the dichotomy large/small and powerful/weak. In fact, there is not necessarily direct correlation between power and size. Inter-organisational power structures are rather based on the type of relationships established. In more classical political science studies, power is defined as the "actor A's ability to make B do something he would not have done otherwise".[46] Political scientists have also made a distinction between power and influence. According to Pateman, "influence is applicable to a situation where A affects individual B, without B subordinating his/her wishes to those of A…That is to say, A has influence over B, and over the making of a decision, but it is B that has the power finally to decide".[47] As pointed out by Ruigrok and von Tulder, the question of how to use these concepts in analysing restructuring and corporate strategies is far from evident (Ruigrok and von Tulder, 1995). In business studies, previous approach to power took into account either the autonomy factor (Burt, 1983) or the centrality factor (Mackenzie and Frazier, 1966). Both focused on the important role of authority, such as government, in shaping transactions and power, but without capturing the sources from which power emanated. In this direction a third perspective, the resource-dependence approach (Pfeffer and Solancik, 1978) contributed by specifying that two of the conditions that determine an organisations' degree of autonomy are the resources that one can obtain from the actor making the demands, and on

[46] See Dahl, 1957 in Ruigrok and von Tulder, 1995, p. 68.
[47] Pateman 1979, pp. 69-70, in Ruigrok and von Tulder, 1995, p. 69.

its own. To understand the hierarchies and their modifications within the production systems is thus necessary to consider both the ways resources can be appropriated and developed. Then, which ones are strategic and enable the use of power or influence over other firms. However, while Ruigrok and von Tulder relate a situation of dependency to the size of the firm, the bigger the easier is to control the value chain, markets, core technologies and then more independent is the firm, in this study dependency is connected to the strategic resources of the firm, regardless of their size and technology. This position raises two questions: firstly, that not necessarily firms have to become big in order to acquire control (though partial) over the value chain; and secondly, that size and technology are important only if viewed in a more general perspective, i.e. looking at their dynamic. It remains that a consequence of hierarchies is the creation of situations of dependency between firms. Still, the dependency between firms is not negative *per se*, but it can also be positive. More attention is to be given to the forms of control that are exerted over the individual firms and that may hinder or favour the development of strategic capabilities.

3.2. Core and rings in industrial networks

For this purpose, the more general concepts of "core" and "ring" are introduced. A "Core" firm can influence or even determine the existence of other firms, thus creating asymmetrical power in the production system. On the contrary, a "Ring" denotes a firm, which power does not determine the existence of another firm. Power is symmetrical and firms' existence is not determined by decisions made in another one. Rings can have *vis-à-vis* the core three different positions: a) dependent; b) interdependent; and c)

independent.[48] Between one position and the other different levels of influence from one firm to another can be exerted. At the end of this continuum, there is a situation of dependency without influence (Ruigrok and von Tulder, 1995).

What needs to be underlined is that the distribution of power, and hence the condition of being *core* or *ring*, in a productive chain is influenced by both quantitative and qualitative factors. The quantitative factor is represented by both the *number of suppliers* and *buyers* in the network. In a situation in which there are a lot of suppliers offering similar products, buyers have stronger power. In contrast, in a situation of monopsony, in which there is only one supplier, the power of the buyers is reduced.

However, there are also qualitative aspects to be taken into account in the definition of the power structure, such as the *specific asset* of the firm, i.e., embodied and disembodied knowledge, and its *specialisation*. In fact, in the case of a buyer in need of a very specific product -that only a specialised supplier can provide having the necessary human and technological capability- opportunistic use of power (by the buyer) is reduced because it cannot turn to another supplier and obtain the same conditions, at least in the short run.[49] This creates in turn a situation of lock-in for the buyer. As pointed out by P. R.Christensen, "When supplies have a critical technical value, which is not replicable, or the suppliers are actively involved in the specifications of the supply, then a contractor is dependent on their supplies and may be eager to safeguard supplies and support stable relationships. In other words, these subcontractors give

[48] Wallensteen, 1973, p. 32, in Ruigrok and van Tulder, *op. cit.*, p. 70.
[49] Harrison and Storper, 1991, p. 412.

strategic value to the contractor. This is partly due to rising exit costs and partly because value can only be extracted in the long run."[50]

Therefore, hierarchies and power structures can hinder the development of knowledge in firms and networks, reducing the generalised growth of all the actors in the network. At the same time, the presence of a lead firm that plays the role of coaching the smaller firms may favour the diffusion of relevant knowledge. The identification of this type of bottlenecks in the functioning of the production systems becomes central for the formulation of development strategies. Therefore, there are bad core and good core, as well as bad ring and good ring positions within a network. The following section presents a taxonomy of production systems, according to the distribution of power, i.e. their governance structure.

4. Towards a taxonomy of production systems

From the combination of different types of core and ring emerges a preliminary taxonomy including four types of production systems (α, β, γ, δ - see figure 2).

The aim of the taxonomy is to provide the spectrum of possibilities that can emerge looking at the distribution of power within a production system. From the outset, it should be taken into account that the dynamic and complexity of industrial restructuring implies that rings and core interact in a very unstructured manner, which means that the taxonomy includes four "ideal types" between which other transitional types of forms of governance can exist.

[50] Christensen P. R., 1999, p. 14.

Figure 2 – Types of Governance and Production Systems

Type	Structure	Definition
α	All Ring, No-core	There is no systematic lead firm, or there is a rotating leader in each new project. There is no hierarchy. Old industrial districts, clusters of independent firms, some kind of informal sector.
β	Core-ring, with coordinating Firm	The coordinating firm is the lead, systematic agent in the input-output system, but the coordinating firm cannot function on its own, nor determine the existence of other firms in the system. There is some hierarchy.
γ	Core-Ring, with Lead Firm	The lead firm is substantially independent of its rings of suppliers and subcontractors; that is, it has the ability to reconfigure at least part of its ring. It can thus determine the existence of some of its ring. Power is asymmetrical; there is considerable hierarchy.
δ	All Core, No Ring	The vertically integrated firm.

Source: adapted from Harrison and Storper, 1991.

4.1. Horizontal governance

The type "α" is an "a-cephalic" (without head) network characterised by a structure without any hegemonic centre, in which there is 'all ring and no core'. It is represented by clusters of specialised enterprises, and by networks of firms in which the leadership rotates. In these networks, there is no centre, and the firms have equal roles and similarly powerful knowledge basis. Situations of dependency are reduced to the minimum. A sudden blockage or dis-functionality in one of the nodes (the firms) should not prevent the network from having the same level of performance only if there is a substituting node with similar level of specialisation. This is generally the case of systems of firms linked together in a project-by-project production, such as for example in the production of independent film in Hollywood, or in the Prato textile district, in which firms are

mobilised by the *impannatore* to produce a specific batch of fabric.[51] It might also be found in the informal leather shoe and bags districts of Naples that are not producing for the high fashion firms located in Milan, but for the local market.[52] This is a case in which there are many firms with the same role in the production system, and with little difference in their knowledge base. The blockage of one of the nodes does not compromise the system. Graphically the type "α" can be idealised in three different network structures: the "Constellation", the "Polycentric Network" and the "Linear model".[53] "Constellation" is constituted by a large and undefined number of firms, dispersed in a given space, and linked by the fact that information about each other's type of production is easy to obtain. It is typical of clusters of small firms, scattered in developing countries urban centres, or at the opposite, of highly technological and specialised small firms in the software industries. Although, the level of information about whom is doing what is very high, the ties between the firms are very weak. The "Polycentric" network is characterised by overlapping areas of knowledge exchange. Each of the firms participating is performing a given phase and has a specific capability that can be easily codified and shared. The centres of knowledge production are many and overlapping, but not redundant. It may also occur in case of firms sharing technology during some particular period of the year and demand. In such cases, the sharing of information and knowledge is very strong and the ties among the firm are very thick, although limited to the duration of the project. According to Orsenigo *et al.* (2001), in this type of networks the growth of knowledge should enable the earlier entrants to embody more general and stable hypothesis. Thus, the creation of a core of earlier entrants, linking with the

[51] Harrison and Storper, *op. cit.*, pp. 412 and 415-416.
[52] Roma, 2001, pp. 98-99.

more turbulent fringe of later, more co-specialised, entrants is expected.[54] Hierarchies might be reduced again with the entrance of agents embodying general hypothesis or very specialised techniques.[55] The "Linear Model", is the network of highly specialised firms, such as some Italian industrial districts. The knowledge about each other's need and the knowledge about the specific operation performed by each of the actors produce a highly developed division of labour. The level of specialisation allows an equalisation of power and no hierarchies are established. Yet, it may occur that one of the firms takes a lead position if the gains from the network externalities are not distributed effectively among the network members.

4.2. Coordinated production systems

Turning to the more hierarchical types of systems there can be found a 'combination of core and ring'. The "β"-type is characterised by the presence in the network of a lead firm that influences the functioning of the system, but does not have the power to decide over the existence of the rings, and cannot leave without them. This type of production system is characterised by a structure where a coordinating lead firm is interacting with a set of rings for the production of a given good, but the relationship is not exclusive and the existence of the rings does not entirely depend upon the lead firm's strategy. It is a situation of systematic coordination that can be found in networks where rings have many customers, such as the rings of the large firm Xerox, or where the suppliers are very specialised, such as in the top quality car brands. Graphically, the β-types' structures can be represented by the "Supplier association", the "Web" and the "Snow

[53] For the graphic representations of these and the following types of network structures see Appendix I.
[54] Orsenigo *et al.,* 2001, p. 489.
[55] *Idem*.

Flake". When the suppliers (the external spheres) are connected with each other and with the core we are at the presence of a "Supplier Association". This is a particular type of network originally developed in Japan in the automobile and electronic industry, to develop a lean supply system in which suppliers co-operate under the coordination of a contractor. The large company is supposed to provide the organisational framework and the cooperation strategy for the supply chain (Christensen and Dalgaard, 2000; Crone and Watts, 2000). It is similar to a "hub and spoke" network (see next paragraph), with the difference that the learning and knowledge development in this network is facilitated by the existence of linkages between the rings. Similar to this is the "Web" type of network, which is a very complex structure. Rings are many and with many customers that can take the coordinator's role. In theory, each ring may become the coordinating core of its own network. If there are only two-three tiers of rings strongly connected, then the network resembles the shape of a "Snow flake". The level of thickness of the ties is quite high, as well as the interactions among members. The coordinating firm transfers information and knowledge through the activities connected with procurement, production and sales. A flow of knowledge between first and second tiers might occur, but the distance from the centre could affect the quality of the knowledge transferred. This structure presents the advantage to facilitate the reach of the end-nodes of the network, although they are not connected directly. However, it has the limit that if an upstream node is blocked, than the circulation in the whole branch is affected.

4.3. Hierarchical governance

The third type of governance structure is the "γ", characterised by the presence of 'considerable core power'. It is typical of the aircraft industry,

the large-volume semiconductors industry of the Silicon Valley, the film industry in Hollywood, the electrical products branch, etc. Likewise, firms such as Nike, Ikea, Benetton, In Wear, etc., contribute to the creation of these hierarchical systems through the establishment of several tiers of subcontractors. In these networks, the existence of the second and third tiers of subcontractors, i.e., the less strategic, is largely dependent on the strategy of the core. Graphically, this network structure may well be idealised in the "Hub and Spoke" and the "Branch". Learning in these networks is not necessarily continuous but may be discontinuous and episodic. The information and knowledge are transferred back and forth from the centre to the periphery, and the links between the external spheres are non-existent or very weak. In the "Hub and Spoke" network, the centre plays a "catalytic role" (Markusen, 1996), and is depository of the core technology or the core market. Accordingly, the core firm transfers stocks of knowledge and information from its own research, marketing and production departments to the production and design department of the supplier, which sends it back in form of finished or semi-finished products. Examples of such networks can also be found in the textile sector, where the "concept house" acts as a core providing design and information about material and quality to the rings, which are very specialised in the specific operation. The "Branch" structure gets closer to the networks of subcontractors and contractors of subcontractors, e.g. an articulated chain of production made of small suppliers interacting with an intermediary, which in turn is interacting with the core. Despite this strong dependency situation, rings can benefit largely from the interaction with the core, while the core may well acquire relevant bits of information and knowledge from the collaboration with the rings, although more rarely.

Finally, there is the type "δ", characterised by a situation of 'all core and no ring', which is represented by the vertically integrated firm. This type of network has been excluded *a priori* since does not conform to the study's hypothesis and method.

The importance given to the qualitative aspects, i.e., the specialisation and the specific assets of the production unit, compared to the quantitative aspects, i.e., the number of actors, in the determination of the status of core or ring, requires to take a closer look to the ways the process of specialisation and the creation of specific assets occurs at the level of the firm, and then at the level of the production system.

5. Resources development and forms of governance

The recent developments in the resource-based view (Wernerfelt, 1984; Foss, 1998 and 1999; Grant, 1991, 1996a, 1996b) and in the knowledge-based view (Nonaka and Takeuchi, 1995; Nonaka and Konno, 1998; Nonaka *et al.*, 1998, Nonaka *et al.*, 2000; Spender, 1996; Cohen, 1998) of the firm may provide a satisfactory framework for understanding what lies behind the concepts of "specific asset" and "specialisation", and how they influence hierarchies and threfore the architecture of the networks.

In particular, the knowledge-based view deals with tacit knowledge as an element continuously built and developed and not only with the dynamic capability as a unique resource, characterised by imperfect imitability and imperfect substitutability (Peteraf, 1993; Foss, 1999). These views have the advantage to eliminate the size and the technological factors. This means that competitive advantages can be achieved and sustained, despite the total absence of high technology and a very little size. An extreme but good

example is the specialised craftsman, researched for its invaluable handicraft works. Accordingly, the ability of the firm to mobilise the strategic resources is likely to depend on other factors than size and technology. Therefore, if on the one hand, the emergence of new forms of industrial organisation might give a certain prominence to small firms, on the other, it is unclear how they can contribute and what benefits they can obtain from this process. The answer to this question can contribute to understand how countries can remain competitive despite the majority of small firms and a specialisation in low-tech sectors. In turn, this can enable to understand what are the bottlenecks that affect the growth of the industrial sector.

This means also that not necessarily each firm has to achieve the condition of core to maintain high level of competitiveness. What is important for the firm and the production system is the internal generation of resources and the ability to appropriate those available from the external environment. In fact, the firm is not only a stock of resources but also a learning structure. The central questions are what resources need to be generated and how the processes of learning can be activated. In the thesis it is assumed that the type of governance creates situations of dependency that might affect the process of learning. However, in a network, dependency is not necessarily negative if is functional to the development of certain competencies of the peripheral firm. It may become negative if for the peripheral firm the non-pecuniary gains from the interactions are less than expected, or non-existent.[56] Therefore, to understand the form of governance of a network is important because it influences the process of

[56] This is to say that the costs of risking to be locked in a situation of path-constrained development because new knowledge is not developed, should be at least, *ceteris paribus*, equal in the long run to the pecuniary gains obtained in supplying the network, or one firm of it.

learning. The learning processes, creating new or improving old resources and capabilities, will in turn reshape the power structures within the production system and hence its governance. In other words, it is not the condition of core or ring that is relevant for the firm, the distinction will always exist since power is ineluctable, but is the way resources are created and developed without leaving the firm or the production systems in a situation of negative dependency. Since small low-tech firms have structural problem in acquiring resources, in particular those related to process technologies and licenses, and rely mostly on tacit knowledge and skills (the intangibles), and since intangibles are a very important source of rents,[57] it is necessary to turn to the way intangible resources are created to understand how small firms can cope with the current process of industrial restructuring.

5.1. Opening the Pandora's box of knowledge management

At this point, before proceeding with the theoretical argumentation, it is useful to clarify the distinction between data, information and knowledge, as well as between different types of knowledge. Information is used to indicate 'facts' about products, processes, and markets. According to Cowan, David and Foray information is defined as a "message containing structured data, the receipt of which causes some action by the recipient agent".[58] The nature of this action is determined by the agent's 'entire cognitive context', which is partly constituted by other information. From this perspective, it seems that agents use some "other" information to decode and interpret information. In line with Arora and Gambardella, this "other" information is the knowledge providing the context within which

[57] Penrose, 1972; Rumelt, 1984 and 1987; Barney, 1986; Spender, 1994; Grant, 1996a in Liebeskind, 1996, p. 93.

information is interpreted.[59] In the seminal article appeared in 1994 in *Industrial and Corporate Change*, Lundvall and Johnson had already started to argue that a distinciton should be made between "codified knowledge", such as that embodied in goods, patents and technologies, and "tacit knowledge", such as that embodied in hands, heads, teams, organisational structures, procedures and cultures.[60] However, a richer taxonomy is needed to answer some of the questions related to the problem of knowledge management and to "reflect the complexity involved in storing and sharing knowledge".[61] In fact, as also pointed out by Johnson, Lorenz and Lundvall (2002) in their criticism to Cowan, David and Foray's quoted paper, the distinction between the different types of personal knowledge (know-what, know-why, know-how, know-who), some of which can be easily codified and transferred whilst other are more tacit, seem to be more relevant in the discussion on both information and knowledge and on the codification and transfer of knowledge (Johnson, Lorenz and Lundvall, 2002).[62] These four types of individual knowledge correspond on the organisational level to "shared information databases" (know-what), "shared models of interpretation" (know-why), "shared routines" (know-how) and "shared networks" (know-who).[63]

Due to the increasing complexity of the knowledge base and the need to co-operate with other firms, know-how (the skills) and know-who (who knows what and who knows what to do, as well as the ability to co-operate with different people) are central in the analysis of industrial networks

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[58] Cowan, David and Foray, 2000, p. 216.
[59] Arora and Gambardella, 1994, p. 524.
[60] The concept of tacit knowledge was introduced by Polanyi already in 1958, see also Polanyi 1966 when analysing the scientist's use of skills and personal knowledge.
[61] Johnson, Lorenz and Lundvall, 2002, p. 250.
[62] For the definition of these four types of knowledge besides the quoted article of Johnson, Lorenz and Lundvall, 2002; see also Lundvall and Johnson, 1994 and Ernst and Lundvall, 1997.
[63] Johnson, Lorenz and Lundvall, 2002, p. 250.

dynamic. Both know-how and know-who are very local and context dependent, and depending on factors such as competencies, skills, social capital and trust. They are rather difficult to be codified in a blueprint and therefore they are very strategic. In the words of Liebeskind intangibles represent "a key source of both Ricardian and monopoly rents".[64] To make them available and meaningful to other firms a process of conversion of the tacit knowledge into some codified form has to occur. This means that the innovator needs downstream complementary assets that enable the firm to commercialise the innovation. A consequence of this process is also the increasing divisibility of general and abstract knowledge and information into pieces that can be reorganised in a later stage. According to Arora and Gambardella by 'abstract' is meant "the ability to represent phenomena in terms of a limited number of 'essential elements', rather then in terms of their 'concrete' features. 'General' is instead the knowledge that relates the outcome of a particular experiment to the outcome of other, more 'distant' experiments".[65] The thrust of their argument is that general and abstract knowledge increases the proportion of relevant information that might be articulated in universal categories and therefore absorbed by the firm.[66] Nevertheless, the generation of knowledge, both abstract and general, remains very sticky and dependent on skills and capabilities, which are firms specific and context depending (Von Hippel, 1990). So, even though the division of "innovative labour" reduces the uncertainty of relying on external suppliers and, consequently, the need for vertical integration, opportunism can arise from the intrinsic difficulty in the ex-ante specificity of intangibles (Teece, 1988). Nevertheless, the cost of transfer of such

[64] Liebeskind, 1996, p. 93.
[65] Arora and Gambardella, 1994, p. 524.
[66] Arora and Gambardella, 1994, p. 527; see also Mangemantin and Nesta, 1999.

information across firms should decrease with the adoption of more universal categories and the use of information that can be utilised in different contexts. Then, again, reducing the transaction costs problem to one factor only, i.e. the transfer of knowledge (Grant, 1996a).

The problem connected to the development of know-how and know-who within a company, and not the problem related to the cost of their transaction is at the centre of the discussion carried-out in this thesis. It is assumed that these types of knowledge are "strategic" being responsible of the different relational positions that a firm can occupy within a network of producers. Through the development of these strategic resources small suppliers can improve their "specific assets" and achieve a good relational position within the network. A good relational position implies a better possibility to develop the firm's individual units of knowledge, i.e., the "knowledge base",[67] and organise its internal patterns of distribution, i.e., the "knowledge frames",[68] for the needed purposes. Therefore, the ability to create this knowledge dynamic (learning) depends on the capacity of the firm not only to acquire external knowledge, but also to absorb it (Cohen and Levinthal, 1990) and integrate it (Grant 1996a).

5.2. Knowledge development as a strategically reflexive process

For small low-tech firms it is rather clear that, due to their structural deficiencies, the relational position depends largely on the development of intangibles, such as the know-how and know-who. The role of tacit knowledge in small firms and low-tech sectors has been highlighted in several studies, such as for example Hansen and Serin (1997) on the plastic

[67] This concept refers to the "individual units of knowledge embodied in a specific group of engineers, elemental technologies, various information-processing devices, databases and patents", Kusunoki *et al.*, 1998, in Nonaka, *op. cit.*, p. 6. Similar definition is found in Saviotti, 1998, p. 845: "the knowledge base of a firm is the collective knowledge that the firm uses for its productive purposes".

industry and Bagella and Becchetti (2000) on the Italian industrial districts, just to name a few. In these studies emerged that 'shared routines' and 'shared networks' are the strength of the small firms' entrepreneurs and workers. Therefore, crucial for their development is the ability to improve these resources, although any transfer of tacit knowledge remains in practice a complex process. This is especially because its transfer and acquisition, regardless of its locus of production, requires mainly face-to-face interactions. At the same time, this does not mean that face-to-face interactions, and hence proximity, are an automatic learning mechanism (cf. for example Baptista and Swann, 1998; Swann and Prevezer, 1996). More important is the type of action that is taken by each firm in the learning processes and what this action reflects. As shown in Sundbo and Fuglsang (2002), in the contemporary economy, characterised by knowledge and flexibility firms are following a precise strategy of learning, which is not given for granted but it reflects both the internal and the external factors: "[…] firms cannot merely adapt to markets as stable environments, they need to be more reflexive and strategic". [69] A firm is reflexive when takes into account the implications of its action on the market ad in the society. It is strategic when negotiate its position in the division of labour. Accordingly, the innovation stemming from the development of new knowledge becomes a strategic and reflexive process in which internal and external forces are intertwined. In this approach also, both the type of governance, learning and markets have a central role in analysing innovation. However, innovation as strategic reflexivity implies a deliberate action by the firm that tries to negotiate its entry in a market and tries to imagine the consequences of this. This kind of action implies that

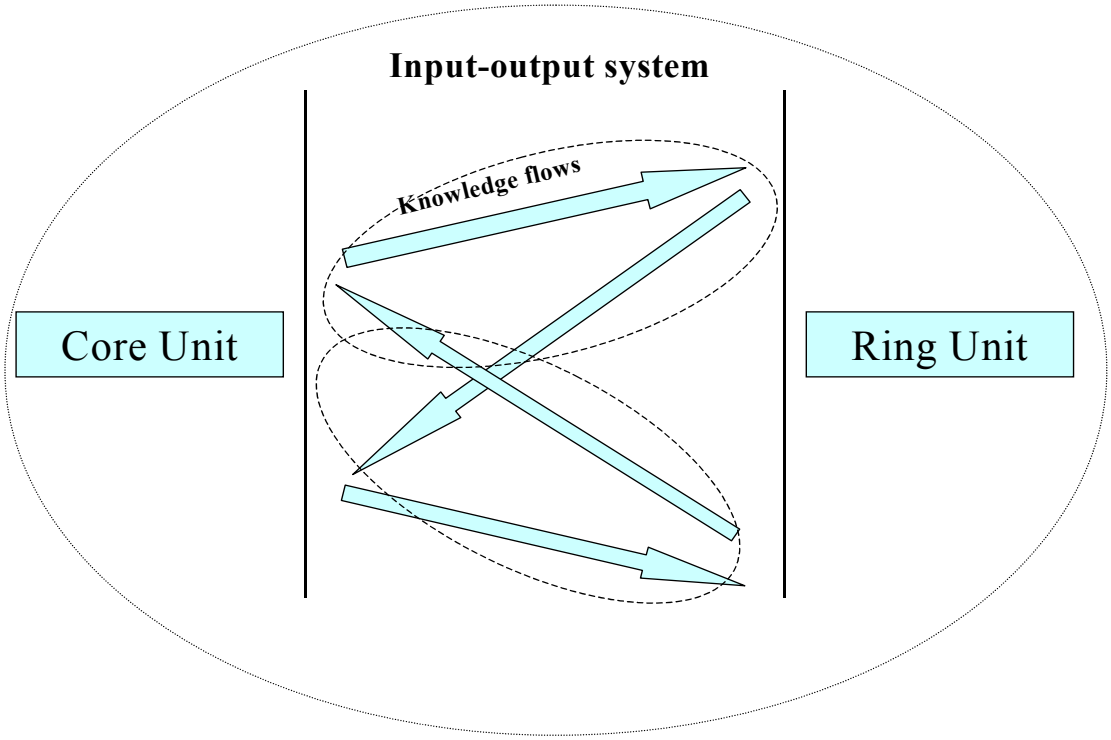
[68] Kusunoki *et al.*, op. cit.
[69] Sundbo and Fuglsang, 2002, p. 1.

the firm has a specific asset and that this represents the strength enabling it to innovate. As I pointed out in a previous study, for small firms the process of learning depends largely on the type of external context that characterises the production system (i.e. the other firms) in which they are embedded (Gallina, 2002). Therefore, for small firms innovation needs to be negotiated each time with the external sources of knowledge. After receiving an order from the core firm the small producer sends back a prototype, which is embodying its own knowledge. It means that its original stock of knowledge might have an important role in the process of de-codification and negotiation of the knowledge transferred by the core unit.[70] In these circumstances a circular knowledge link, characterised by a double-loop knowledge flow, is established between the core and ring units in the production system (figure 3).

Innovation as strategic reflexivity provides the necessary framework to understand innovation in a complex environment. However, the limited focus on one firm in relation to its environment does not take into account the dynamic of the other firms and of the markets. While useful for understanding the complexity of the interactive nature of the process of innovation, the approach take for granted the nature of the strategic and reflexive forces that characterise each firm innovative activity.

[70] Gallina, 2002, p. 97.

Figure 3 – Knowledge flows in the production system



In their attempt to gain a better position in the network firms exchange knowledge following their strategies and trying to fulfil external expectations.[71] This figure adds something different from the 'user-producer' interactive learning, in the sense that other factors are taken into account. In fact, firms (core and rings) are embedded in an input-output system governed by certain power structures. Therefore, knowledge flows back and forth mirroring the strategy of a single firm, the expectation of the external environment and the power structures that regulate the process of learning in the production system.

This way of interpreting knowledge flows and development attempts to reflect the complexity of the factors responsible of the growth and survival of the firms in the production systems. Networks should not be

[71] See for example Stuart, 1998.

considered as given and immobile, but in a restlessness state of flux in which both internal and external forces contributes to their architecture's co-evolution, co-development and performance. The variable geometry of the networks and production systems represents a challenge to the small firms activities. Such instability and the difficulty to enter with a stronger role in the negotiation process for the development of new know-how and know-who can have important repercussions for their survival.

In order to understand how small firms in low-tech sectors can benefit from the process of knowledge creation and development in a complex environment, it is necessary, at this point, to overcome the logic of the analysis at the level of the individual firm, focusing instead on the dynamic of the process at the level of the system.

5.3. Knowledge development in networks

A main weakness of the resource-based view and the knowledge-based view, common also to the transaction cost theory, is the focus on a single firm (or on single transactions), providing less insights into the process by which groups of firms develop common and individual capabilities by interacting (Lorenzoni and Lipparini, 1999). Increasingly, the network should be perceived as a place, a "*ba*" (Nonaka, 2002; Nonaka and Takeuchi, 1995) where stability of norms and ties create a functional working framework. The idea of the network as a 'meta-place', i.e., a "shared space for emerging relationships" (Nonaka and Toyama, 2002; Nonaka and Konno, 1998) enables to perceive knowledge-creating processes as context-specific. Which means that each network has its own knowledge dynamic.

To explain this knowledge dynamic in networks, it is helpful to resort to the notion of "collective learning" proposed by Håkansson (1993) and

Capello (1998), to indicate a process of interactive learning over several actors.[72] In this sense, the market is viewed as a decentralised, but effective, learning system in which non-pecuniary externalities take place. As a result, both stability (through the establishment of rules and norms) and variety (due to the existence of different knowledge bases) are established. The latter, in particular, is close to the notion of "external economy of cognitive scope", developed by Nooteboom.[73] Different knowledge bases are created with constant interactions with outside sources of cognition, which in turn provide non-redundant and relevant novel-knowledge. Collective learning is a process based on continuity, stability, intensity and dynamic synergies of linkages, "creating common rules and routines imposed by hierarchy and control".[74]

The mechanisms through which collective learning takes place and the sources of knowledge are many and involve internal and external actors. Physically speaking, learning takes places in the firms' departments, the association of producers, the laboratories, the trade-fairs, by checking the Internet home pages of competitors, and within and between all types of institutions for industrial and technological development. The ways for learning to occur are by doing, absorbing, forgetting, exploring, searching, interacting (and many other *–ings* developed by the creativity of scholars with different disciplinary backgrounds). The internal actors are the firms' personnel, and the external ones are the other firms in the network, the institutions devoted to the development of specific knowledge (technological centres, research institutes, universities, development

[72] Håkansson, 1993, p. 215, in Foss, 1999, *op. cit.*, p. 6. and Capello, 1998, p. 354. In the thesis the concept of 'collective learning' used differs from that of 'regional collective learning', which is largely discussed in a special issue of Regional Studies (Vol. 33, Nr. 4, June 1999), and has as central aspect the proximity factor.
[73] Nooteboom, 1992 in Noteeboom, 1999a, p. 795.
[74] Capello, 1998, p. 354.

agencies, etc.). All these places, ways and actors that are behind the learning processes can contribute to the production of new knowledge to different extents, depending on the intensity and dynamic of the learning processes. However, the dynamic of knowledge development, and the avenues that collective learning may follow in different network architectures, depend upon:

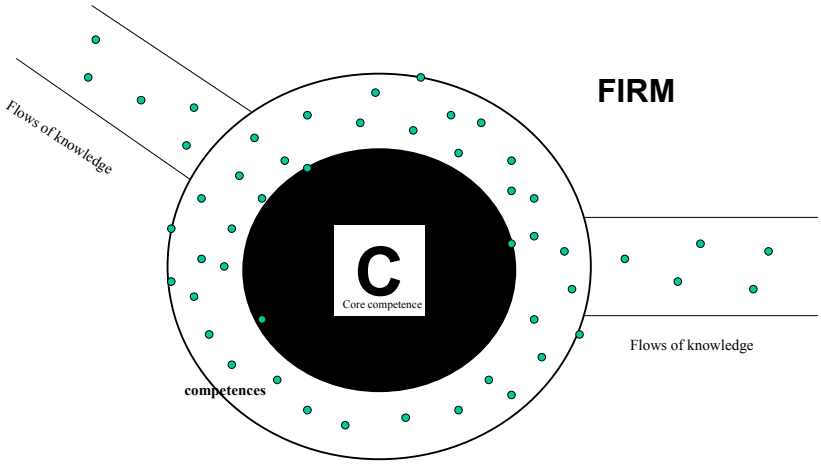
a) the firms' attitude towards sharing knowledge with other network members (the willingness factor) and,
b) the possibility to pick-up knowledge from different sources (the access factor).

It may be easily predicted that every firm protects the core capabilities/competencies/assets, and that only selected information/ knowledge will flow from one firm to another. The limits of the diffusion of the core knowledge can be highlighted putting each node under a zoom, to make the nodes' structures visible (figure 4). Only the less strategic competencies (the imaginary small dots of the figure) are shared with the other actors. Although, in many instances it can occur that the firm is forced to open up the black area to other firms if it wants to collaborate with them effectively. Otherwise, firms giving up the core assets will automatically reduce their power and worsen their position in the network. Therefore, if the firm does not enlarge the black area represented by the core competence, it will be relegated to the role of dependent ring and distant from the lead firm.

Likewise, the possibility to develop new knowledge depends also on the possibility to access to different sources. In fsct, although the focus on the core competencies (Prahalad and Hamel, 1990) has the advantage of

partly eliminating the size effect access to different sources is clearly linked to the structural dimensions of the organisation. Taking this into account, a necessary condition for a collective learning with redistributive and spillover effects is the creation of a *"shared common environment*". In fact, it is not only necessary that there is a 'common environment' (such as a production system) for firms to learn, but also that the knowledge is free to flow from one node to the other. Teacher and students can sit in a common environment, i.e. the classroom. But if they do not share their knowledge by engaging into interactions, then collective learning will not take place.

Figure 4 – Network nodes under the zoom



Having underlined the processes of learning within and between firms and the necessary conditions for these to occur, it is now possible to link the analysis of the structural factors with that of the evolutionary elements. In the next section is exemplified how the structural factors, the markets characteristics and the processes of learning are interrelated and what do this imply for a "theory of production systems".

6. The structural dynamism approach to production system analysis

The need for a theory of production systems that takes into account the intertwining of all these different elements (markets' dynamics, governance structures and learning trajectories) arises from the limits that firms' and networks' theories have shown in explaining the dynamic of industrial systems of firms in an increasingly complex and internationalised economy.

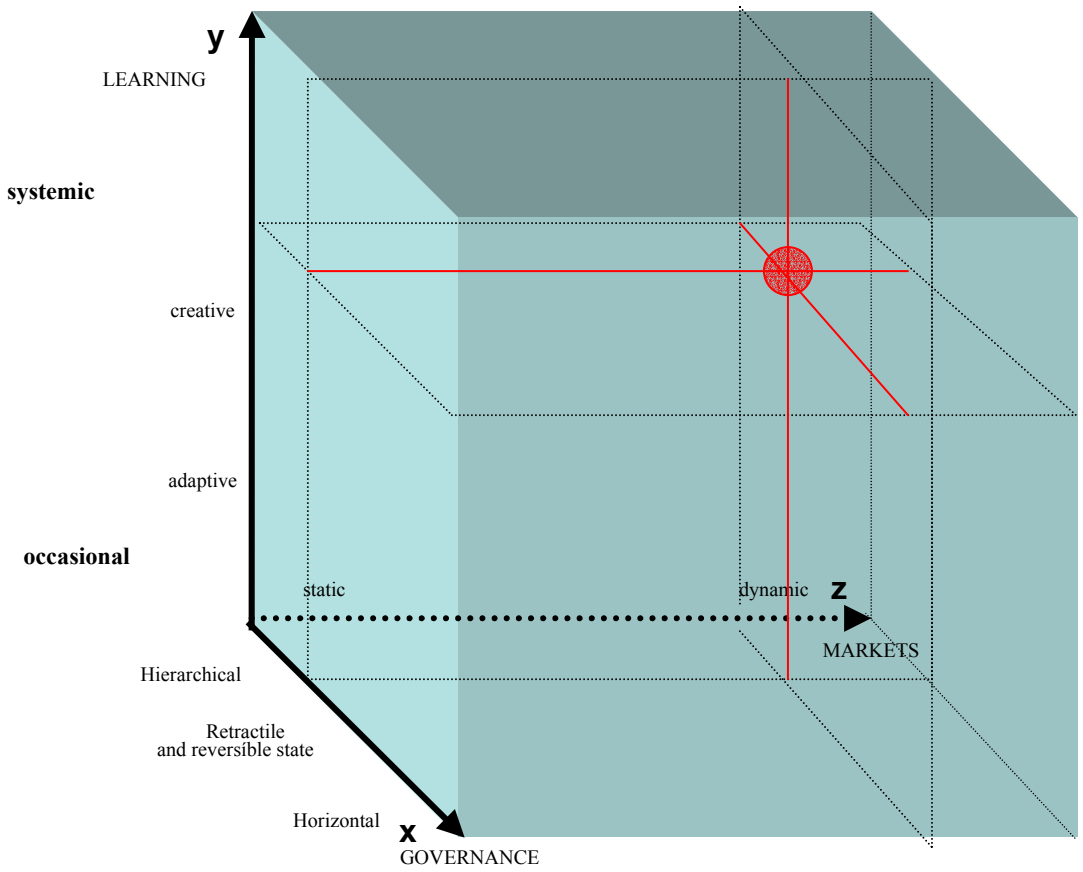
The approach presented in this section has the aim of providing an explanatory synthesis of the interrelation between these elements, and hence to provide a framework for understanding the different production systems' dynamics and their effects on the individual firms. The implications for the small firms in each of the production systems analysed will be discussed in chapter five. The graph simplifies a way for representing the various positions that a production system (i.e. the set of inter-firms relationships governed by power structures) might have in the economic system represented by the tridimensional diagram of figure 5 (the cube).

It is a representation that -once given the values of the variables- can project each production system in a tri-dimensional space. The axes on the graph represent the three variables:

1. Markets dynamics are represented on axis *z*, where the closest to the origin the more stable is the market;
2. Governance structures are represented on axis *x*, the more hierarchical the closest to the origin;

3. Learning trajectory on the axis *y*, where the closest to the origin the more occasional is the learning.

Figure 5 – Graphic representation of the "structural dynamism approach"



Explanatory note: The dot represents a production system projected in the space of the cube according to the values of x, y, and z. In this specific example, the production system is characterised by a very hierarchical governance structure (x), in which learning is taking place in a systemic way with the participation of many actors (y) and in a very dynamic market (z). The intersection point of the three geometric planes corresponding to each value on the three axes is the location of the production system. Any change in one of these values will modify the production system's position in the model.

Market represents the independent variable, which means that a change in the governance structure or the type of learning occurring within the network does not affect the dynamic of the market but vice versa.

Markets are chosen as the independent variable mainly because they vary enormously independently from the local production system governance and learning, i.e. their dynamic is dependending on the strategies of the large transational companies. The advantage offered by this approach lies in the ability to identify the direction that –given a certan market- a production system can take following a modification in either its governance structure or its learning trajectory. This means also that the measures for intervention in one of the factors (such as for example innovation and/or industrial policies) can follow-up the change accordingly, in order to recover the lost position or to gain a 'better' one.

The approach presents limits as well. As already pointed out in the first chapter referring to the studies on innovation, a main limit is related to the measurement of factors such as learning, governance and market's dynamic. This problem has been barely tackled in studies on innovation and industrial economics. Another limit is represented by the market factor. In fact, if the unit of analysis is the production system it should be clarified whether the market is that of the industry of the rings or of that of the core. In the thesis both are taken into account. However, these are problems that cannot and will not be solved in this context. It is most important to discuss the use and the possibilities offered by the model to understand the dynamic of production systems. Looking at the three variables it can be stated that:

1) A learning trajectory can then be represented by the degree of intensity (occasional learning *vs* systematic learning) and the degree of participation (adaptive *vs* creative) (Belussi *et al.*, 1998). For both core and ring systematic learning can produce better results in terms of knowledge development. Inter-firms learning processes are

systematic when the interactions occur with a certain frequency and aim to specific objectives (Powell, 1998; Powell *et al.*, 1996). This might create more space for creativity and "shared common environments". In contrast, learning is occasional when it occurs on a discontinuous base and is merely a process of adaptation to the knowledge transferred by the core without further processing. However, in the evolutionary perspective of Tyre and Orlikowski, "episodic process of learning may help the rings to avoid the solidification of habits and assumption that often accompanies experience with a given design, technology or techniques".[75] The learning trajectories modify the production system architecture and re-shape the power relationships. In principle, two different production systems with the same type of governance structure can present opposite learning trajectories. However, it is assumed that due to the avenues that knowledge flows can have in less hierarchical governance structures, they are supposedly more conducive to systemic learning.

2) Governance structures change also according to the dynamic of the markets. The ongoing re-structuring process has put in discussion the traditional conceptual schemas used to explain the processes of concentration and de-centralisation. Vertically integrated organisations are more common in certain industries requiring high levels of capital investments, while de-centralised forms of production have a better performance in other industries and activities in which

[75] M. J. Tyre and W. Orlikowski, 1996, p. 797.

niche strategies and high external economies of scale and low internal economies of scope prevail (Harrison, 1994).

3) Regardless of the level of integration, in this study markets are viewed as moving from static to a dynamic state and *viceversa*, following the restructuring processes. Static markets are represented by stable industries with few incumbents and incremental technological change, while dynamic markets are those characterised by frequent new entries and exits and radical changes in process and product technologies. The specific characteristics of the markets of the production systems analysed are discussed in chapter three. Here, it is important to stress for the discussion that production systems in static markets are less exposed to competition from new firms, domestic and foreign, and competition is usually based on product innovation (Jelinek, 1996). Production systems in dynamic markets are more subject to fluctuations of the international markets and high pace of technological progress in process technology. Competition is mainly based on investments in new technologies.

Just to give some examples, in a production system characterised by a strong core, the lead firm can induce both occasional learning, in which the rings learn by adapting to the new conditions, or systemic learning process, in which the rings have the possibility to be "coached" in the learning process by the core firm. In the former case, if the production system's core firm is in a static market, in the sense that there is a consolidated number of players, and competition is sustained only being one of the oligopolistic firm, the lead firm has to bear all the task of introducing both new products and processes. It can remain competitive only acquiring a monopolistic

position. An example of this is the traditional industries' production systems such as footwear. As the core of a very hierarchical system, the U.S.-based transnational company Nike imposes a very adaptive learning process on the rings (especially second and third tiers): new production processes and products are introduced by the lead firm. On the contrary, if the core is in a dynamic market characterised by more process innovation and new incumbents, then the firms has either to integrate vertically some of the production phases in order to maintain a technological and knowledge lead towards the competitors or has to engage in continuous process innovation in cooperation with the rings. In this case learning needs probably to be more systemic, which is therefore more beneficial for the rings as well. These are just some of the situations that a production system, and the firms in it, can face. These preliminary considerations are the foundation upon which a "theory of production system" can be built once the empirical material has been thoroughly developed.

7. Conclusions

This chapter presented the theoretical framework that will be utilised to understand the political economy of a production system, and in particular the implications of the process of globalisation for the small firms in the low-tech sectors. The excursus on the typology of production systems, on the forces behind their dynamic and on the types of learning that characterise each of them, has highlighted that in order to understand network and production systems' structural dynamisms it is necessary firstly, to understand the specific assets of the firms, and secondly, to look at how they influence the governance and power structures regulating the systems.

In non-hierarchical networks firms might learn from each other on a project-by-project base, and thus reduce their dependency on the other firm "specific assets". This type of governance should be the most conducive to the creation of a "shared common environment". Networks with a coordinating firm have more hierarchy. The lead firm can set the working frames and conditions, such as, for example, establishing quality standards or organisational settings. This situation of dependency for the rings is linked to their specialisation and their access to different markets. Instead, in hierarchical networks, the core firm has a substantial power to determine the presence of a firm in the network. Learning can be based on imitation and use of existing knowledge, or on invention, development or redistribution of new knowledge. In this governance structure the lead firm shapes at its convenience the network structure, creating or eliminating situation of "negative dependency", which might encourage or discourage destructive competition among rings. However, even in very hierarchical networks there can be voluntaristic collaboration. Therefore, the learning capability of the less powerful units may improve anyhow, but it still depends on the will of the core to help building up a stronger learning capability and knowledge base of the rings. In such situation the dependency of the rings from the core is "positive".

This chapter has also showed that behind the emergence and evolution of networks, the qualitative factors have a fundamental implication for the understanding of production systems' dynamics. This approach highlighted that learning and evolution of the structures are independent from the type of sector and the size of the firms. They are rather linked to the evolution of firms' resources and competences and the consequent hierarchies and dependencies created within the network, and hence from what it might be defined the "political economy" of production systems. The simultaneous

unfolding of internal forces and external forces defines the dynamic of the production system and therefore of the economy as a whole.

The discussion carried-out in this chapter has mainly served to develop a set of concepts that will be adopted to analyse the processes of learning and innovation in a selected sample of industrial production systems. When firms are increasingly investing in their architecture of relationships, they are making networks very complex and with different centres of decision-making. At the same time, it should be taken into account that the interaction between firms, both among rings and between rings and core, creates an idiosyncratic network knowledge base with a stability of norms and ties and variety of sources. This in turn has implications for both the individual firm and for the system as a whole, creating and destroying internal and external economies of scope and scale. An increase in the external economies of scope and scale modifies the division of labour within the network, and can improve the capability of the firm to elaborate existing knowledge. An increase in the internal economies of scale and scope contributes to the growth of the production units and of their stock of resources. Opposite effects might emerge in case of decreasing external or internal economies of scope and scale. An input-output system may thus be more or less dynamic, according to its learning capability. However, the capability to produce and exploit the internal and external economies of scale and scope depends on the qualitative aspects characterising each network and especially the ‘specific assets’ and the level of ‘specialisation’ of the production units. These assets and their evolution determine the network power structures. Therefore the survival of the units within a production system depends on the type of learning trajectory that may take place, giving a certain market dynamic. Providing some examples of production system, has shown this relationship between

power structure and outcomes, emphasising the role of innovation, especially of the systemic one, for the evolution and development of the units and thus of the system as a whole. Learning and innovation processes are therefore under the focus of the analysis. Both because they stem from the use of resources, and because they are responsible of the evolution of the systems' architecture, which in turn affects the distributive effects of learning and its sustainability for the individual firm -and for the system as a whole. An attempt to systematise the interrelations between the different elements (learning, governance and markets' dynamics) has resulted in the introduction of an analytical framework particularly useful for understanding the production system structural dynamism. This emphasises the need to have as starting unit of analysis the production system, which in turn is de-constructed into the analysis of the single unit assets, the power structures and the learning processes.

In line with Knoke (2001), it can be also concluded that in the previous studies on organisational change and networks a lot of emphasis was put on the structure of the inter-organisational ties, but there was very little research on the relationship between the structures and the outcomes. According to Human and Provan, "What is known about which network structures work best and what kinds of outcomes might be expected from network membership is quite limited".[76] How firms benefit from the network membership and how the sources of advantages emerge are still unanswered questions. In this light, this approach can contribute to a better understanding of the existence and survival of small low-tech firms in high factor costs countries. In turn, looking at how the power structures influence the shape of the network, we can say that the governance

structure is responsible of the trajectory that learning, and hence new knowledge development, might follow.

In the following chapter, the structure and dynamism of the Danish industrial sector and of the markets selected for the analysis are presented in order to provide a picture of the external dimension of the political economy of production systems. In particular, special attention will be paid to the dynamic of the industries in which the ring and core firms in the sample of production systems analysed are classified. This, together with the description in chapter four of the production systems and of their individual firms, will enable to have the complete picture of the characteristics and dynamics of the micro, meso and macro levels of the analysis.

[76] Cf. Human and Provan, who emphasised the importance of network structures for the learning process, 1996, p. 370. See also Midgley *et al.*, 1992 on the effects of network structure on the diffusion of innovations.

CHAPTER THREE

Structures and Markets Dynamics in the Danish Manufacturing Sector

1. Introduction

The structure of the Danish manufacturing sector is similar to most OECD countries where a majority of small and medium-sized enterprises constitutes the underwood of industrial production. However, unlike from other OECD countries, both big and small, Denmark is characterised by the limited number of very large industries. According to Lundvall, this situation coupled with limited foreign investments and trade has created a very coherent national production system (Andersen E.S. and Lundvall, 1988; Lundvall, 1999; Edquist and Lundvall, 1982), in which the few large firms have provided the market for the majority of small and medium-sized enterprises. About half of them are in fact subcontractors to large enterprises (Andersen and Christensen, 1998), while the other half produces directly for the local markets, and only a few produces for the export markets (Lundvall, 1999). Therefore, as far as the market is kept alive from the internal demand there is no need to worry. However, recent studies showed that in Denmark large firms are gradually cutting the number of suppliers, following the diffusion of new management techniques, which aim to rationalise, segment and select strategically the supply base (Christensen, 1999; Kaufmann *et al.*, 2000). This process is a consequence of the general restructuring of the industrial sector worldwide, where increasing concentration of markets is followed by a strategic de-

centralisation of production. Since this type of global competition is cost driven, although the compliance with quality standards will upgrade the production capability of the selected manufacturers (Sakai, 2002), it is unclear whether small firms are squeezed by this process or will represent the cornerstone of a future flexible organisation (Christensen, 1999). However, the position of the products in the product life cycle needs also to be taken into account in this type of analysis (Christensen, 1999).

Cost-driven global strategic sourcing might affect the cohesiveness of the national or local system of industries creating throat-cut competition. Nevertheless, the learning processes that can be activated by foreign firms or by the internationalisation of national companies can produce positive knowledge spillovers overall. It is therefore necessary to move from the national system perspective, in which informal locally bounded and non-written rules are the key to the cohesiveness of the system, to the production system perspective, where the system is a complex "relational regime" of interactions not necessarily rooted in the local or national system, but with a global reach. In an increasing internationalised economy, with mergers and acquisition, strategic alliances and joint ventures involving international players, it is difficult to rely only on a local trusty environment to remain in the high value markets. The re-organisation of production might cause a degradation of the local production systems towards less valuable markets, while few players controlled by foreign capital will harvest the fruits of the investments in human capital made in the past decades. This issue is even more sensitive due to the fact that the specialisation of Danish industries is in productions in which there is a high level of concentration at global level, and local multinationals cannot compete for long with the giant transnational players.

This chapter will attempt to analyse the macro level of the analysis, i.e. the markets, in which the core and rings of production systems are operating, with the aim to provide an overall view on the dynamic of the process of industrial restructuring, and in order to have the general perspective at hand when analysing the likely consequences for the small firms in the sample. The chapter is organised in the following way. The challenges that small countries face in the new wave of internationalisation are discussed in next section. Section three gives an overview of the Danish industrial sector. In section four, particular emphasis is given to the dynamic of the markets in which the companies of the production systems analysed are classified. Section five concludes the chapter.

2. Small open economies facing globalisation

The hypercompetition imposed by the globalisation of the economy and technology and the emergence of new markets are not sparing the traditional sectors, and the small wealthy countries in the OECD-area. New ways to add value to production and to save costs are a priority on the agenda of the governments of the industrialised nations (Petit and Soete, 1999). However, the process of globalisation of trade and technological innovation is increasingly driven by large transnational companies less rooted into the national economy, and therefore less prone to pose national interests before those of the corporation. How to enter the high value segment of the global supply chain is a stringent need for the high cost factors countries, and in particular for the small ones, such as for example Denmark.

How Nordic countries are highly dependent on international business environment has been widely discussed in the literature (Katzenstein, 1985;

Dunning and Narula, 1995; Ruigrok and Tulder, 1995; Narula and Hogenbirk, 1999; Bjorkman and Forsgren, 1997). According to Bjorkman and Forsegren the dependency of Nordic countries is refleceted by the smallness of the region as such and by its characteristic and history.[77] Besides the historical factors, three other structural factors should be added.

Firstly, it is a general feature of small countries to be open and dependent on the world economy because "lack of economies of scale" which are necessary to a number of critical industries, such as chemicals, iron and steel, transport equipment, machine industry, electrical equipment and textiles. Small countries have to import more than the larger industrial countries. Secondly, the "small market" argument should be added to the small supply argument. Firms in small countries internationalise to find markets for their production. This means that they seek to specialise and achieve economies of scale in export markets, and in few particular countries (Katzeistein, 1985). Thirdly, small countries need to limit their vulnerability *vis-á-vis* the fluctuations of the international business cycles and therefore they developed the so-called "niche strategy".

In the last 30 years, Denmark achieved high growth and employment despite the "small country squeeze" problems. According to Maskell, 1996 and Maskell *et al.*, 1998, this was not only due to a specialisation in niche markets or export success, but also to other factors, such as the creation of strong social interactions, and generalised consensus, deeply rooted in a national "village-economy" culture. The cohesion created by this combination of socio-economic and cultural elements has encouraged the creation of an environment conducive to informal knowledge sharing, and the awareness of sharing the same problems linked despite the size and the

[77] Bjorkman and Forsgren, 1997, p. 11.

location at the edge of continental Europe. Lundvall and the IKE research group at Aalborg university have developed and used the notion of "national system of innovation" to explain the comparative advantages stemming from close interactions between users and producers (Lundvall, 1992). Accordingly, these kinds of interactions are the sources of the lasting and strong positions in international markets, for both users and producers. The resulting national industrial complexes are strongly rooted in the country's institutional setting. While this approach is still valid to explain the development of particular industries and specialisations, which success would have not been possible without the engagement of the institutions and a close cooperation among industrialists' (besides their ability to harness the historical accumulation of the local knowledge),[78] today's' level of internationalisation is likely to override the national dimension (Sklair, 2002).

In the following section an overview on the Danish industry is provided with the aim to show both the structural deficiencies and dynamic advantages of Danish firms.

3. Danish industrial structure: too little big firms and too much low-tech?

The Danish industrial structure, and the economy in general, is influenced by the presence of a very large public sector, a majority of small firms, and a very limited presence of large corporations. Roughly speaking, about 33 per cent of the active population is employed in the State sector; about 40 per cent is employed in the market-based services, and the remaining 27

[78] See for example the study on the wind-mill industry by Gregersen and Johnson, 2000 and Karnoe, 1996.

per cent in construction, agriculture and manufacturing.[79] Employment in manufacturing alone accounts for more than a sixth of the labour force, corresponding to 490,000 people in 1998.[80] Sector-wise industrial employment is mainly concentrated in the food, beverages and tobacco, in machinery and equipment industries, in wood products, printing and publishing and in the chemicals and plastic products, which together account for 60 per cent of the total industrial employment. Other important sectors are the basic metal industry and electronic industry, employing about 10 per cent each of total manufacturing labour force.[81] Similar figures mirror the distribution of gross value added by manufacture.

Danish industrial production is dominated by the so-called low technology sectors, such as food and foodstuffs, paper and printing, metal products, and wood and furniture. These sectors account for about 53 per cent of industrial production and a very limited contribution to the figure on gross R&D expenditure. In contrast, only three sectors, i.e. pharmaceutical, precision instruments and telecommunications, account for more than 43 per cent of the total R&D expenditures, although their contribution to employment and production is very limited.[82] In 1998, a third of Danish R&D expenditure in manufacturing was spent in the pharmaceutical industry.[83] The picture was described by Lundvall as a "polarised business structure with some small very highly technological islands (pharmaceutical and cellular communications) in a sea of medium (metal products and machinery) and low technology (food and furniture) products".[84]

[79] Andersen *et al.*, 2001, p. 31.
[80] Nielsen, 1999, p. 8.
[81] Nielsen, 1999, p. 10.
[82] Data are from 1990 and are taken from Drejer, 1998, in Lundvall, 1999, p. 37.
[83] Andersen *et al*., *op. cit,* p. 43.
[84] Lundvall, 1999, p. 37.

Despite the limit that the ratio R&D expenditures/GDP presents as a measurement of innovative capability of firms and sectors (Cf. Hansen and Serin, 1997) this situation has created anxiety and obsession within the Danish political and economic debate that continues until today. Maintaining competitiveness introducing higher contents of research and technology in production is believed to be the main solution to economic and political problems. Otherwise, as pointed out already some fifteen years ago by Braendgaard:

> "Denmark will drop-out of the high-income bracket and turn into a museum economy on the European fringe… This adage can be probably be extended to Europe".[85]

It is not the object of this chapter to discuss the political economy implications of the low level of R&D expenditures in Denmark compare to the OECD area. With the exception of the pharmaceutical industry, the concentration of the R&D efforts in the low-tech industries is prevalent in other high-income OECD countries. Therefore, it needs to be emphasised that firstly, the specialisation of a country is not just a matter of changing patterns of investments, but it is rather something rooted in the historical and cultural models which change is a long and gradual process. Secondly, the specialisation in medium-low and low technology products is not necessarily low value production. In the medium-low and low technology sector, research and development expenditures are not very high since firms concentrate the efforts on continuous and incremental innovation in products and processes, which do not require the presence of engineers or sophisticated research laboratories (and which are less counted in the

[85] Braendgaard A. 1987, p. 62, in Pedersen L. *op. cit*.

innovation statistics) (see for example the studies of Maskell *et al.*, 1999 and Lorenz, 1999 on the furniture industry). This type of specialisation can be considered a handicap or not, depending on the points of views. Still, it is an objective of policy makers to concentrate the resources on those sectors that show a higher growth rate in employment and productivity. The *potential structural handicap*[86] of Danish manufacturing until now have been avoided maintaining a specialisation in the less R&D content sectors by keeping a high flexibility and 'innovativeness', and by using a very sophisticated process technologies, combined with a strong competence in industrial design and marketing (Lundvall, 1999).

3.1. Danish Small and Medium-sized Enterprises

In Denmark, small and medium-sized enterprises (SMEs) are the prevalent type of industrial establishment. Despite the major mergers occurred in the last twenty years the industrial structure has not changed. SMEs are considered to be those that employ less than 100 employees.[87] They represent about 95 per cent of the total number of workplaces, account for 40 per cent of the employment in the manufacturing industry and 25 per cent of industrial exports (Table 2).[88] These figures are quite similar across Europe Union countries. The main problem with these figures is that the role played by the very large enterprises is not clear enough.

[86] Andersen *et al.*, *op. cit*, p., 2001, p. 59. Emphasis in the original text.
[87] In general, it should be emphasised that statistics about SMEs in Denmark are very inconsistent and not homogenous. The different parameters used to classify the SMEs (in the EU statistics SMEs are those with less than 250 employees, in the OECD statistics those with less than 500 employees) makes cross-country comparison very difficult. Furthermore, the Danish system does not allow picturing the limited presence of very large enterprises.
[88] On the export capability of Danish SMEs see the study of P. H. Andersen, 1995.

Table 2 – The role of SMEs in the Danish manufacturing sector

	Enterprises (% of indus. Ent.)	Employment (% of indus. Empl.)	Export (% of indus. Exp.)
Size/year	**1997**	**1997**	**1997**
>10	60.9	10.0	3.6
10-19	15.9	7.6	2.2
20-49	12.8	12.4	6.5
50-99	4.9	10.3	13.5
Total SMEs	**94.5**	**40.3**	**25.8**
100+	5.5	59.7	74.2
Total	**100.0**	**100.0**	**100.0**

Source: own elaboration from Denmark Statistics, various years.

SMEs are concentrated in the traditional sectors characterised by the use of "low technology", and are often family-based. The owner, the chairman of the board and the managing director are often the same person, whereas to meet the legal requirements, other members of the family become directors, 'the old aunts and uncles boards of directors'.[89] They are mainly oriented towards the local markets, have a high level of specialisation, and mostly occupy market niches. The links with the international markets are generally indirect, through either intermediaries or through supplying large internationalised companies or multinationals (see Mønsted, 1984).

The small number of large enterprises and the high level of internationalisation have contributed to the diffusion of subcontracting relationships, although the exact share of subcontracting on total production is not known. This has important implications for Danish industry. Independent firms are more subject to the industry specific developments, while subcontractors are highly dependent from fluctuations of the international markets and multinationals strategies, and also in a less autonomous position with respect to the process of innovation. Still, even

[89] Madsen, 1986, p. 4.

subcontractors can have a strategic role in the national economy if specialise in highly valuable competencies, and contribute to their diffusion in the national knowledge base. The survey carried out by Andersen and Christensen, has shown that in almost 40 per cent of the cases Danish subcontractors have been characterised as traditional subcontractors, while only 30 per cent as strategic development suppliers (Andersen and Christensen, 1998). This means that most subcontractors are used as buffers and cost efficient suppliers, i.e., as a reservoirs of large firms, and are exposed to the make or buy decision of their customers, which are at the same time their main competitors (Christensen, 1999). More than half has domestic relationships both on the supplier and on the customer side, while another 20 per cent have local suppliers but foreign customers (international daughter companies located in Denmark).[90]

The spreading of subcontractor relationship can have negative effects if the contribution given by the subcontractor can be easily substituted, and a general negative effect for the economy if the replacing firm is located in another country.[91] Therefore, as pointed out in the mentioned studies it is important to understand that the role of subcontractors can be different. However, although these studies are an important source for understanding the implications of having a certain position in the production system, they do not provide an explanation on the obstacles that small firms face in the development of their relationship with the large firms.

The small firms in the thesis' sample are representative of both independent suppliers and dependent subcontractors with different level of "strategic importance" within the network. Before analysing the positive or negative influence of the relationships among firms, and the implications

[90] Christensen, 1999, p. 32.

for their development is necessary to take into account the trends in their specific markets. Therefore, it is important to include both the specific industry dynamic, looking at the market trends, and the restructuring process at the industry level. The following section presents the main trends in the industries object of study. The micro dimension related to the internal dynamic of the firms of the selected networks is investigated in chapter five.

4. Trends and structures in the selected markets

The aim of this section is to present the main trends and structures of the small firms markets (different types of packaging) and of the markets that they supply (confectionery, juice and pharmaceutical). The packaging sector is characterised by low level of exports due to its low price/volume ratio, therefore foreign companies interested in the Danish market are mainly investing taking over local production facilities. The end markets supplied by the small companies in the research are instead characterised by high exports and outward foreign investments aiming at compete with foreign producers in foreign markets.

4.1. A overview on the packaging industry for the food and pharmaceuticals

The packaging sector is undergoing major restructuring. According to the analysts of the sector, the trend towards fewer players on the ball will continue at a rapid pace. Especially in the box/carton industry acquisitions and consolidations in the packaging and equipment manufacturing sectors

[91] Though, the argument of the welfare gains for the population is often used to justify the de-localisation of the productive activities.

forge ahead unabated. This paragraph will focus in particular on the specific markets of packaging for the pharmaceutical and food sectors, which are those supplied by the small companies in the survey.

As one of the largest industrial sectors in the world, the world-wide packaging market is estimated to be valued 475 billion USD, roughly half of the value of finished packaging materials, which includes the value added from conversion, such as printing.[92] Globally, the industry employs more than 5 million in some 100,000 companies, representing between 1.5 and 3 per cent of worldwide gross domestic product.[93] In Europe four countries, Germany, France, Italy and UK, share 90 per cent of total European production.[94] By value, paper and board accounted for 36 per cent of sales of primary packaging materials in 1997, plastic, metal and glass were 34, 20 and 10 per cent respectively.[95] These figures are expected to change so that plastic containers will achieve a lead position in the coming years. However, this trend does not represent a direct threat to the corrugated carton packaging sector, since corrugated still transport plastic beverage bottles, for example, and the presence of a plastic pack will always justify the use of a board sleeve or a carton outer. This is instead enlightening of how different materials may directly compete but also find symbiotic relationships.

In the specific market of consumer healthcare packaging, the figures show that it represents 4 per cent of the packaging industry.[96] More than 80 per cent of the demand of drugs is concentrated in seven countries (the U.S., Japan, Germany, France, China, the U.K. and Italy). Despite a general flat growth for packaging markets, the pharmaceutical packaging industry

[92] Higham, 1999.
[93] Paperboard Packaging, 1998.
[94] *Idem*.
[95] *Idem*.

is growing, and this will put more emphasis on the role of packaging as essential part of the drug delivery system and of the marketing mix. A primary reason for the increase is the rise in the output of existing products, the accelerated rate of introduction of new products, and the imminent expiration of patents on a very large number of popular products. Pharmaceutical firms are putting increasing emphasis on the importance of packaging in the manufacturing process. Packaging in the pharmaceutical industry is not anymore considered as a simple container to hold tablets, but as a key element in developing product and brand identity. Furthermore, the packaging is increasingly used as a drug delivery mechanism. In the U.S. market the forecasts show that plastic containers will retain the largest share, although the blister packaging is showing higher growth rates.[97] In Europe, the situation is the opposite, 85 per cent of solid drugs are packed in blisters, compared with less than 20 per cent in the U.S.[98] Plastic containers will remain the top-selling medication package also in the developing countries due to cost advantages and processing facility, compare to blister packaging technology.

Compare to other packaging industries the demand in the pharmaceutical packaging is largely influenced by issues such as safety and compliance. In addition, as the industry becomes global the regulatory measures established in the industrialised countries will greatly influence other markets as well. Innovation in this sector will be driven by the combination of speed to market, quality control and material and design compliance to the safety regulations. The market is also facing other challenges due to emergence of internet-based pharmacies and a shrinking pool of pharmacists, coupled with a situation of increasing number of

[96] Pilchik, 2000.
[97] Forcino, 2001.

prescriptions needed by an ageing population. This can lead to the increased use of automatic dispensers and hence of compatible packaging, with for example machine-readable bar codes. Technology innovations go hand in hand with the demand and requirements from the market, especially in the use of software for modelling the packaging structure, discover its barriers and find out the product stability requirements. The introduction of flexible packaging, such as blister package, represents a major innovation in this industry. Blister packaging was introduced in the early 1960s, but only recently has its use spread in the pharmaceutical industry. The higher degree of automation, typical of the flexible packaging, enables the reduction of labour cost, although there is a break-even point when blister packaging loses its advantage and plastic containers become more cost-effective.[99] Another important innovation in this sector that will increase the use of plastic containers is the introduction of electronic chips in the packaging that for example will remember the patient to take the medicine.

In the food market, and in particular the confectionery and juice sectors, consumers have begun to demand that products not only meet a functional but also an emotional need. Once a product enters the market, in order to have longevity and sustainable market share, marketing experts believe that it should have an emotional connection to the consumer. Therefore, also producers for food consumer packaging are under strong pressure for innovation. In this market, the demand for folding carton is undergoing a period of change. In many industries, such as for example dairies, folding carton packaging is a mature product and in many segments of the market plastic containers are replacing paper containers.

[98] Pilchik, 2000.

Furthermore, the paperboard packaging industry is facing problems of overcapacity, which solution in the long-term is probably an even stronger consolidation of the industry.[100] A recently published analysis by Market Tracking International, which reports on packaging suppliers, "predicts the demise of more traditional materials such as corrugated and carton packaging, because it says fast-moving consumer goods and supermarket distributors desire more flexible packaging that requires less shelf space".[101] To this it should be added the environmental pressures faced by large companies to reduce waste of materials. The main trend in the packaging industry for food and confectionery is the growth of the flexible materials packaging. According to the Flexible Packaging Association, the switch from rigid to flexible forms of packaging, an ageing population, end-users' drive for reducing costs, new product introductions in the flexible packaging and the growth in stand-up pouches, will continue to impact the coming years' sales.[102] Despite a marginal increase in the demand, paper packaging will remain the main source of packaging, mostly for its low cost, environmental compatibility and use in laminations. Still, most interesting is that although flexible packaging stands on its own, flexible materials often work in conjunction with rigid containers, such as carton boxes containing bags, bottles, etc. Therefore, the possibility to have mixed materials packaging is another example of the variety of applications and innovations in the packaging sector. At present, three-fourth of flexible packaging is used in the food sector, due to the possibility to use it for very diverse products.

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[99] Pharmaceutical products distributed in quantities higher than 100 units can be packaged more economically in bottles.
[100] Donohue, 2000.
[101] In Higham, 1999.
[102] Falkman, 1999.

These trends stand to confirm that the sector is very innovative despite the low-tech content of its output. Innovations are both incremental, such for example the modification of the design or closures, and radical, such as for example with the introduction of new materials (the PET bottle, the flexible materials) or the introduction of electronic chips in the caps, or the TetraPak concept.

Firms in the packaging sector have also an increasing need to achieve economies of scale and create monopoly situations, while maintaining a lean structure. The concentration process takes the form of specialisation in one segment of the market and in the related filling-in technology, while de-centralisation takes the form of subcontracting agreements with small and medium-sized companies. For example, one of the largest packaging multinational, the British Rexam, has decided to specialise in the production of consumer packaging in glass, aluminium and plastic abandoning the other types of packaging. To pursue this objective in the Nordic markets is making agreements with companies producing glass for beverages. Similarly SCA, the largest supplier of corrugated board packaging in Europe, with a market share of 15 per cent, has acquired Danisco Pack carton operations in Denmark, Norway and Germany. By now SCA supplies 44 per cent of Danish corrugate board packaging market through a network of small and medium-sized producers. These are big companies with global markets and local strategies; in fact they distribute or produce the packaging material through local companies, granting licenses.

4.2. Trends in the core-firm industries

Two out of the three end-market enterprises of the survey are in the food industry. The third one is a pharmaceutical firm. These sectors are

also undergoing a process of restructuring, which on the one hand sees the concentration of production in very few giant transnational companies due to a consolidation pressures in the international retail trade, and on the other, the proliferation of numerous market niches occupied by small enterprises. In these segments, the packaging has a paramount role. This is due partly because the brands are related to a specific appearance, and partly because the loss resulting from deteriorating quality during the storage is a main concern for the manufacturer. The packaging has also to take into account a consumer market characterised by the ageing of a significant portion of the traditional confectionery eaters, the fragmentation of traditional households, and new types of demand coming from increasing ethnic and cultural diversity in society.

Another important aspect of the global restructuring process is that Nordic countries represent a small share of the world market. Large multinational companies, such as Unilever, Philip Morris, Kraft and Novartis, are pulling out from their peripheral markets, reversing the trend of the 1980s and early 1990s when diversification was the order. Nordic companies have been put on sale. The smallness of the Nordic markets implies that it can be supplied by companies of smaller dimension, which in turn requires suppliers of packaging of smaller dimensions as well. The dominant Danish company in the chocolate sector Toms has only 1500 employees and the dominant dilutable juice, Rynkeby, controlling two-thirds of the market has only 350 employees.

The trends in the end-market of the third production system analysed are partly different. The three larger Danish companies, Nycomed, Novo Nordisk and Lundbeck are responsible for 12 per cent of the total production of pharmaceutical in Danish territory and the rest is supplied by foreign companies and nine importers (in 1996).

Despite the proliferation of external providers and small bio-tech companies, outsourcing of research and manufacturing operations in the pharmaceutical industry is estimated at 20-25 per cent, which is relatively modest compare to other industries such as automotive, electronic or sporting goods industries.[103] Therefore, on the one hand seems realistic that the growth in the use of external providers will continue, but on the other seems difficult to forecast the creation of few "hollow" corporations financing and controlling every segment of the market. Parallel to this is a dynamic process of growth in the niches controlled by small and medium-sized companies concentrating on specific areas of the drug market. In this way, the analysts believe that small and medium sized companies will use their resources more effectively and will outperform their large competitors. Furthermore, SMEs are increasingly contracting out much of their production and even rely on small R&D start-ups to discover new products.[104]

The market for drugs and pharmaceuticals is quite differentiated and so is the market for its packaging. Small packaging firms can survive more easily than in the food sector. In the packaging for pharmaceuticals the entry barriers are very high due to the standards and the lengthy registration of a new packaging or packaging supplier. However, once in the market the replacement by another company is also more complicated. It is also a sector in which innovation (new types of closures, new material such as blisters, and electronic packages), the ageing of the population and the shrinking numbers of practitioners are forcing packaging firms to find new solutions. This can imply new investment and increased financial resources that only few companies can undertake. However, the specific

[103] Polastro *et al.*, 2000.
[104] Milmo, 2001.

characteristics of this sector, its segmentation and standards, create a demand for packaging that can be supplied by small and medium-sized enterprises provided that are dynamic and able to respond to the innovation coming from the market.

5. Conclusion

The sectoral specialisation of the country and the structure of the industrial sector mirror the typical small country problems. In addition, a manufacturing sector with small firms and little concentration of capital does not look interesting for classical state intervention, through for example take-overs. Furthermore, despite the growth of R&D intensive sectors such as pharmaceutical, chemicals, biotechnology and telecommunication, the economy remains specialised in foodstuffs, furniture, machinery and instruments and textile (Gallina 2002). These are technologically mature sectors which competitive advantages in the future will be based on wages' level with the risk of establishing a "Myrdallian" vicious circle. Nevertheless, there are also products in this "low-tech contents" specialisation that are generally oriented towards the high segment of the market, such as for example in the design furniture industry (Lorenzen, 1998).

The presence of a large number of small firms with very limited direct export capabilities has also been highlighted, as well as the high export performance of the country explained with indirect links to markets through intermediaries, distributors or larger customers. This implies a high dependence on both markets fluctuations, multinationals and intermediaries strategies. The stability and density of these networks in terms of long-term contracts, reliability, financial and technological support by the large

corporations (or the state) is vital for the survival of the small firms. At the same time, the good performance in the low-tech markets might imply that for small firms the human and knowledge assets represent the key to survive. Thus, it emerges the importance to analyse the dynamic of the growth of these assets. The next chapters will look at how the internal relations governing the production systems work, and how they are related to the external environment represented by the other firms, the institutions, and the markets.

This chapter has also presented some of the reflections that the "Danish" case has stimulated in the academic debate. The performance of the Danish economy has been explained by the strong social interaction within and between business organisations and institutions. The ability to solve problems informally and to establish close interactions with suppliers and competitors are some of the most important "small countries advantages", especially when the general welfare of the economy is based on continuous and incremental innovations and interactive learning. However, the qualitative change in the organisation of production, which the analysis of competition in the selected industries has shown, represents both a political challenge to the "village economy" and also a need to find other explanatory frameworks for understanding the contemporary industrial dynamics.

The case study will try to investigate how this change is affecting the capability of Danish small firms supplying large companies to survive and improve their relational position in the production systems. The small country problems have been avoided building up trusty and dense relationships between private and public institutions and concentrating on niche markets. How increasing internationalisation of the economy and hence the entry of foreign interests in the scene can undermine the Danish

production systems will be discussed in chapter five. The next chapter aims to describe the three cases of production systems selected for the analysis. This will provide the overview on the internal assets of the firms (the micro level) and on the power structures affecting the learning and governance dynamics.

CHAPTER FOUR

Three Industrial Production Systems: Structure, History and Specialisation

1. Introduction

The aim of this chapter is to describe the structure, history and specialisation of the production systems selected for the analysis. The activities of the firms are presented in order to identify core competencies, productive specialisation, and the type of relationships with the suppliers and customers, which are responsible of the type of governance structure. For the sake of clarity, the nodes of the network are presented according to their markets (consumer goods or suppliers of intermediate inputs). The governance structure, the learning processes and the process of capabilities' development are instead analysed in chapter five.

It is necessary to stress from the outset that each firm has a network of relationships, made of suppliers, customers and joint-partners, that is quite difficult to "trace down" completely. Therefore, each of the networks selected for the research should be considered as just a part of a broader production system, like a "slice" of a whole cake. Although all the firms identified in each of the network are presented, the analysis will focus on the small suppliers of packaging and packaging materials. The choice to focus on the packaging producers is based upon the fact that the number of small suppliers of packaging have been constantly reduced by large companies, over the last few years, and that the sector is in theory less

vulnerable to the process of de-localisation in low-wages countries due to the high volume/price ratio.

This sector is also undergoing a general process of restructuring that sees few large players on the scene creating strong monopoly situations and specialising in one specific segment of the market (glass, metal, carton, etc.), and a process of innovation that is involving both the downstream industries (raw material suppliers) and the upstream industries (filling-technology producers). Markets are also becoming more differentiated (new niches in the food and confectionery sector), and with an ageing consumer requiring lighter (plastic bottles or flexibles) or sophisticated packaging (smart pharmaceuticals containers). Small companies can in this way remain in the market filling the niches. It is assumed that the innovation is an important element but it is not the only strategy for the small firm to survive, and that the chance to innovate depend also upon external factors, such as for example the presence of shared learning environments.

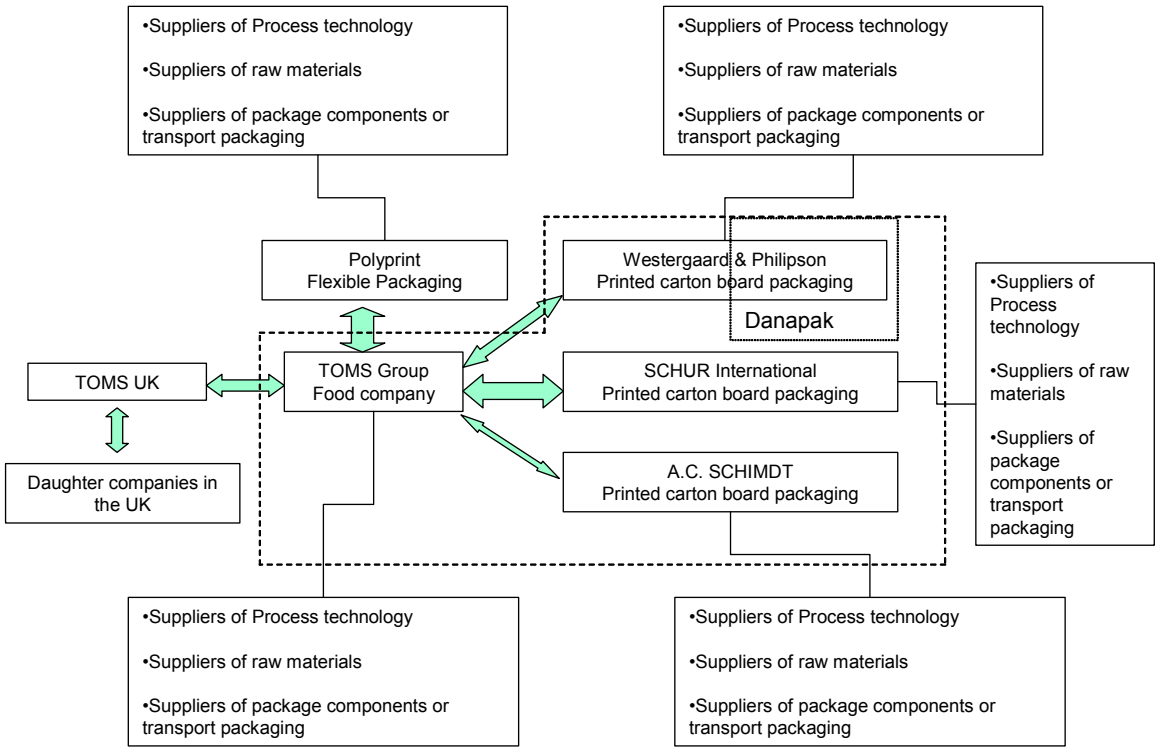
2. Production System No. 1

2.1. Introduction

The reconstruction of the first input-output system has had as point of departure the small packaging producer “Schmidt”. Its main customer was “Toms” a leading Danish-owned food company specialised in the production of chocolate and confectionery, employing more than one thousand and five hundred workers. The input-output system observed is composed of the producer of the good for the final market and of the

suppliers of packaging material. At the time of the interview,[105] there were several suppliers of carton and flexible packaging, some suppliers of sales packaging (to transport and store the products), and of packaging components (e.g. layers of corrugated carton to place between the top of the chocolate box and the chocolate). Within the group of suppliers of packaging material, four were considered the most important for the type and number of pieces provided by the food company. Of these, one is a large company according to Danish standards (Schur International), while the others are small companies (Westergaard & Philipson, A. C. Schmidt and Polyprint).

Figure 6 - Production System No.1



Note: The dashed area represents the clusters of firms interviewed. The block arrows represents the direct links between firms

[105] December 1999.

Schur produces different types of packaging and packaging systems, but is supplying to Toms only carton boxes. Westergaard & Philipson and Schmidt are specialised in carton boards packaging, while Polyprint is supplying flexible packaging. A main feature of this input-output system is that Toms' strategy of selection of suppliers of packaging is causing the ending of the relationship with two of the 'historical' suppliers (A. C. Schmidt and Westergaard & Philipson). This process is particularly important considering that firstly, Schmidt and Westergaard & Philipson are geographically closer to Toms, and secondly, that they were supplying carton board package similar to that provided by Schur. Therefore, a follow up interview was made with both A. C. Schmidt and Westergaard & Philipson in August 2002. In the following sections, the history and activities of each of the firms interviewed for this input-output system are described.

2.2. History, markets and specialisation of the Consumer Good Producer

The large confectionery company "Toms Group" is the PS-1 end-market firm. The firm has an articulated network of relationships with suppliers and customers that in the last two- to three years has been subject to major changes, following the implementation of an entirely new management strategy. The company was founded in 1924 and since then has expanded dramatically, employing today more than 1,500 employees. The plant is located in the outskirts of Copenhagen. In recent years, the expansion has led the company to pursue a strategy of acquisition in both the local Danish market, such it was the case of BonBon (September 2001), and in the British confectionery market. This is actually not something new, since the strategy of its founders has always been to acquire other smaller Danish confectionery companies, such as Anthon Berg, Galle &

Jessen and Høeghs Lakridsfabrik, during the 1950s and the 1970s. The move into the British market has occurred through the acquisition and merger of two local companies, resulted in the creation of Toms UK. To this, has followed another acquisition of a medium-sized company with a leadership position in UK's manufacture of gums and jellies. Today, Toms has achieved the position of the second large manufacturer of the sugar confectionery market in the UK. The company aims to gain a larger share of the Scandinavian and of the British markets, hence the need to involve the suppliers of packaging in the process. Despite the good relationship and satisfaction that Toms had with Schmidt and WP, the larger supplier in the network was selected to replace them in the supply of folded carton packaging. This was justified with the need to have a more reliable supplier in terms of quantity, and with which an integration of productions would have been possible. Therefore, it was not the quality of the small suppliers output that is put in discussion, but their production capacity. However, the supplies of flexibles are still provided by the medium-sized company despite the fact that Schur can provide flexibles as well.

2.3. Presentation of the Suppliers

Until end of year 2000 one of the major supplier of folded carton packaging to Toms was A.C. Schmidt. This is a folded-carton packaging producer employing about seventy-five workers and supplying both the pharmaceuticals and the food markets. The company is located in the outskirts of Copenhagen, close to the highway that leads to the bridge to Sweden. The grand father of the current owner founded the company at the beginning of last century, and it still maintains its family-business orientation. In the 1920s, the production of carton boxes started, and in the aftermath of World War II the demand of printed packaging led to the

separation of the company in two distinct businesses: wooden and carton packaging. The wooden company has further specialised in the production of timber goods, while the carton packaging has evolved into a modern packaging company with its own design department. The firm serves the local market and is trying to expand the sales in the Baltic countries, Poland in particular. Sporadic exports occurred towards the Færo Islands. Since the end of 2001 the company has lost its main customer (about 70 per cent of the turnover) and therefore there has been a major diversification in the customer portfolio, and new investments in capital equipment in order to reach higher economies of scale. This has led to specialise in the packaging for the medical industry.

The other small supplier of carton board packaging of this production system was Westergaard & Philipson (WP). The company, which was established in 1977, is located in the outskirts of Copenhagen (Greve). WP is the result of the latest of a series of take-overs of a small and very old packaging company, which has been supplying Toms for eighty years. WP is specialised in the packaging for the confectionery industry and for the medical industry, and in the production of labels. Despite the acquisition of another small packaging company, in 1995, WP remained a small enterprise with a labour force of forty people. Since August 2001, the company's majority of shares were held by Danapak (which is owned by Arla-MD Foods). The decision to sell was not only due to the loss of the main customer (Toms), but also to the fact that the size of company was considered by the general director too small to face the new wave of concentration in the packaging industry. Furthermore, according to the owner/director an expansion would need a financial investment that he was not willing to do undertake, due to its age close to retirement. He does not like the idea that the son should take over the family company with such a

huge debt. Rather, he prefers the son to undertake a career in a large company such as Danapak. The entry of Danapak in the management board has meant that now the company supplies pharmaceutical companies. However, WP still provides to Toms a particular type of packaging that was invented during their business relations.

Concerning the flexible packaging operations, originally Toms' suppliers of flexible packaging were two. By now, the only supplier is Polyprint. This choice has pushed the other company to close down. Polyprint has specialised since its foundation, in 1976, in the production of flexible packages for the food industries. It is employing about seventy people and is located in the Southeast part of Jutland, in the nearby of Schur. Polyprint is well endowed with the latest technologies available in the press, printing and lamination of the films. Despite the wave of mergers and acquisition in the sectors, and the direct competition of Schur flexibles, the firm remained in this production system.

2.4. Preliminary Considerations

The strategy followed by Toms to have only one supplier for each type of packaging was justified during the interview with the purchasing manager on the ground that, quality being equal, prices will be lower and production capacity larger, two necessary factors for the pursuing of its expansion strategy. The specific knowledge about packaging for the food industry was common to all the suppliers. Furthermore, technological innovation was not a deficit in the small companies. Packaging design capabilities for example were very high due to the use of highly sophisticated colour digital printers. Therefore, the main discriminating factor for the small suppliers of this production system were price and size. Smaller volumes and higher prices were not in line with the strategy of

expansion of the confectionery company. Especially for the high volume of folded carton packaging required, Toms' has also undertaken a restructuring of the organisation of the production, which needed the introduction of a communication system able to coordinate its production with that of the suppliers. Therefore, the choice to select only one and larger supplier was based on this organisational innovation as well. This has created a new form of governance in the production system and a learning mechanism, which cannot be sustained if one of the two partners keeps a hidden agenda. However, this relationship is not only about trust (trust existed also with the smaller suppliers), but it is mainly about the mutual necessity to solve problems and co-develop the productivity levels through innovations. This was not considered feasible with small companies such as Schmidt and WP. The smaller producers of folded carton were excluded from the market due to their specialisation in a sector of the packaging industry that requires increasingly economies of scale, and that is threatened at the same time by the introduction of other products, such as the flexible package. However, the specialisation in flexibles did not enable the smaller flexible packaging producer to remain in the network together with Polyprint, and although also Schur produces flexibles, Toms is purchasing the flexible packages only from Polyprint. This is due to the fact that Polyprint is more specialised than Schur in the production of flexibles and that its flexible packages are of better quality compare to that of Schur.

The consequences of this change in the governance structure are still unknown for Toms. Toms has increased its dependency from Schur, which might flatten out the existing hierarchy and provide a better learning environment. However, for the small packaging firms the exclusion from this production system has had different consequences. Despite their assets,

the small folded carton packaging companies had to shift market and enter the packaging for pharmaceuticals, either independently or under the control of another firm. Opposite, the flexible packaging company can still remain the food market due to the niche characteristic that flexibles still have in the food industry.

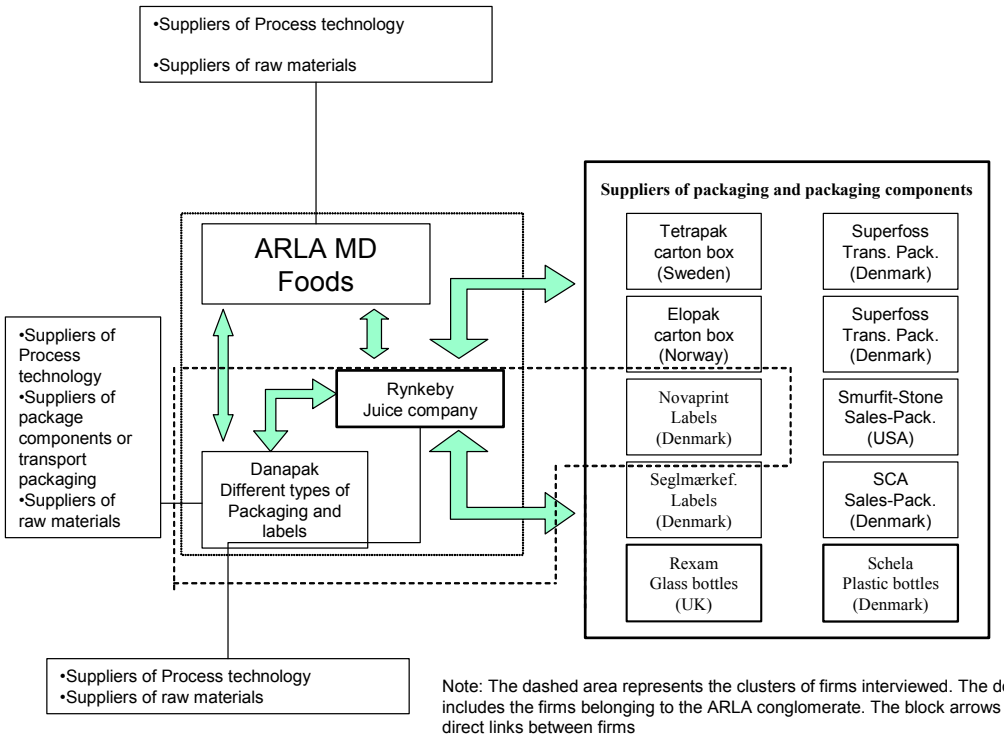
3. Production System No. 2

3.1. Introduction

The second production system has been reconstructed starting from the Danish juice and food company "Rynkeby". This has been, since 1997, a daughter company of Arla-MD Food, which is a joint venture between Arla Sweden and MD Food Denmark; both multinational corporations specialised in the production of dairy products. This production system is different compare to the previous one. In this the end-market firm is not an independent company. However, despite the acquisition by Arla-MD Foods Rynkeby maintains a quite independent production and purchasing strategy, and so far, little changes have occurred in its network of suppliers. Through the acquisition of Rynkeby, which controls 85 per cent of the Danish diluted juice market Arla-MD Foods has strengthened its already dominant position in the Scandinavian market for food. Rynkeby is specialised in the production of diluted juice, concentrated juice, jams and orange marmalade. The packaging is supplied by large producers such as Tetrapak, Rexam, AssiDömain able to supply also the filling technology. Sales and transport packaging are also supplied by large company, such as Smurfit-Stone, SCA and Superfoss. Some of these suppliers are corporations with leadership position in the European and global markets.

In this production system there are also two small companies supplying the labels for the glass and Pet bottles, Novaprint and Sæglemarkfabrikken. Both have a dominant position in the Danish market for labels.

Figure 7 – Production System No. 2



Note: The dashed area represents the clusters of firms interviewed. The dotted area includes the firms belonging to the ARLA conglomerate. The block arrows represents the direct links between firms

3.2. History, markets and specialisation of the Consumer Good Producer

The end-market of this production system is the juice and jams company Rynkeby. Rynkeby was established in the early thirties for the production of apple most. Today, it is the leading juice company in Denmark, employing about 350 workers in its two plants. During the last twenty years, it has acquired some smaller producers that were in difficulty due to the situation of over-capacity that characterised the 1980s and to the concentration of distribution chain. Production takes place in two different

locations, one hosting the manufacturing of jams, and the other the manufacturing of juice. Both plants are located in Fyon, the island between Zealand and the peninsula of Jutland. In the Danish juice industry, Rynkeby has a leadership position, but the company works also for private labels, owned by big distributors and as manufacturer of other brand under license agreements.[106]

The change of property is changing slowly the purchasing strategies of the company. The mother company is imposing a better coordination of supplies, especially in the packaging where large volume means better prices. Instead, in the case of raw material Rynkeby has a very independent purchasing strategy, since Arla-MD Foods does not have the specific knowledge about the juice sector. At the same time, the take-over has reduced the dependency from the suppliers of raw materials (the giant trading corporations). According to the information obtained during the interview, the juice company has one or two suppliers for each type of transport or sales packaging and packaging materials. In the following sections, an overview of the suppliers of packaging is provided (see figure 8).

3.3. Presentation of the Suppliers

This production system is characterised by the presence of both very large and very small suppliers of packaging materials. Both flexible and rigid packaging are supplied by global players such as Rexam Holmegaard, (subsidiary of Rexam UK, a global leader in consumer packaging and the world's largest beverage can maker), Schela Plast, Superfoss, SCA Packaging Denmark (100 per cent owned by Svenska Cellulosa

[106] This is another example of the ongoing process of concentration without centralisation, where large players subcontract through licence agreements their private labels productions.

Aktielbolaget, which is part of the larger SCA Group one of the largest corrugated board packaging producer of Europe), Smurfit-Stone Container Corporation (responsible for about 11 per cent of the world's containerboard market production, and 17 per cent of Danish market share), AssiDomän, Tetrapak and Elopak. The small companies in this production systems are specialised in the supply of packaging components and in particular labels. The two small companies are Novaprint and Seglmærkfabrik. Novaprint employs about eighty people, while Seglmærkfabrik is a very small enterprise employing only nine people.

Novaprint produces labels for the packaging of food product containers. It supplies Rynkeby, various Arla daughter companies, and very large companies, such as Coca-Cola, Carlsberg, Beaunlies. The company produces only labels in a plant operating three daily shifts for five days a week. The label production is divided into normal and special, such as the peel-off labels for recycling bottles -although this is just a small part of the total production. According to Novaprint's manager, the label sector is not particularly innovative and economies of scale are very important. The assets of the firm lie in the capacity to invent new label concepts. Even in the design, Novaprint has a small department and rely mainly on the interaction with the large customers designers. Recently Novaprint focused on a particular type of labels, i.e. campaign labels, in which the major innovation lies in the organisation of the production. For example, labels with different designs are mixed together, giving the possibility to the customer to have in the same box-case of soft drinks one product but with different labels. Novaprint supplies Rynkeby with normal labels for PET and glass bottles. According to the sales manager of the company, despite Rynkeby represents only one per cent of Novaprint sales is considered a very important customer. From next spring, Novaprint will also supply

directly Arla-Md Food. However, Arla-MD Foods has recently took-over Danapak, a major label and packaging producer in Denmark, which also controls WP, specialised in labels as well. According to the manager of Novaprint, this is not a main worry, but instead the internationalisation of production is the real treat.

3.5. Preliminary considerations

The second production system is characterised by the presence of several large multinational companies and few very small and medium-sized firms. The Danish company Rynkeby, holding a leadership position in the Danish juice and jams markets, was taken as the starting point of this production system. Around this, it has been reconstructed the network of packaging suppliers. As in the previous production system the customer buys raw material from large trading companies, while some process technology is bought locally or internationally through intermediaries. The filling machinery is provided by the large suppliers of packaging material, such as Tetra and Elopak. The structure of this network is influenced by the fact that Rynkeby is not anymore an independent firm but became a daughter company of the Danish/Swedish multinational (Arla-MD Foods), which is gradually imposing a new purchasing strategy to Rynkeby regarding the supplies of packaging. This has meant a better integration of purchasing between Arla and Rynkeby, and a general reduction in the total number of suppliers. According to Rynkeby purchasing manager, a "coordinated" purchasing of packaging is seen as an advantage -especially when the suppliers are very big companies, such as in the case of carton board packages. Otherwise, he continues, a loss of independency in the choice of the suppliers is not particularly attractive. Especially because sometimes it has meant the loss of a good and established supplier, with

which more interaction for the development of new products was possible compared to what can happen with the large packaging companies, which seem to limit horizontal flows of knowledge. Packaging companies such as Tetra-Pak, SCA, Smurfit-Stone, Elopak, etc., have a very integrated production, from project to product and the filling machine. It is thus quite difficult to put together these big players in the joint development of a new packaging, and at least it did not happen under the auspices of Rynkeby or Arla-MD Foods. The size factor seems to produce a bad attitude towards openness and collaboration. It should be also taken into account that although Arla-MD Foods is an important player in Scandinavia, is relatively small when compared to these multinational packaging companies. The effects of the take-over on Novaprint and Sæglemarkefabrik in this production system are still unclear, although Novaprint's leadership position in the country and the very small niche occupied by Sæglemarkfabrik will likely enable their survival in even more turbulent markets.

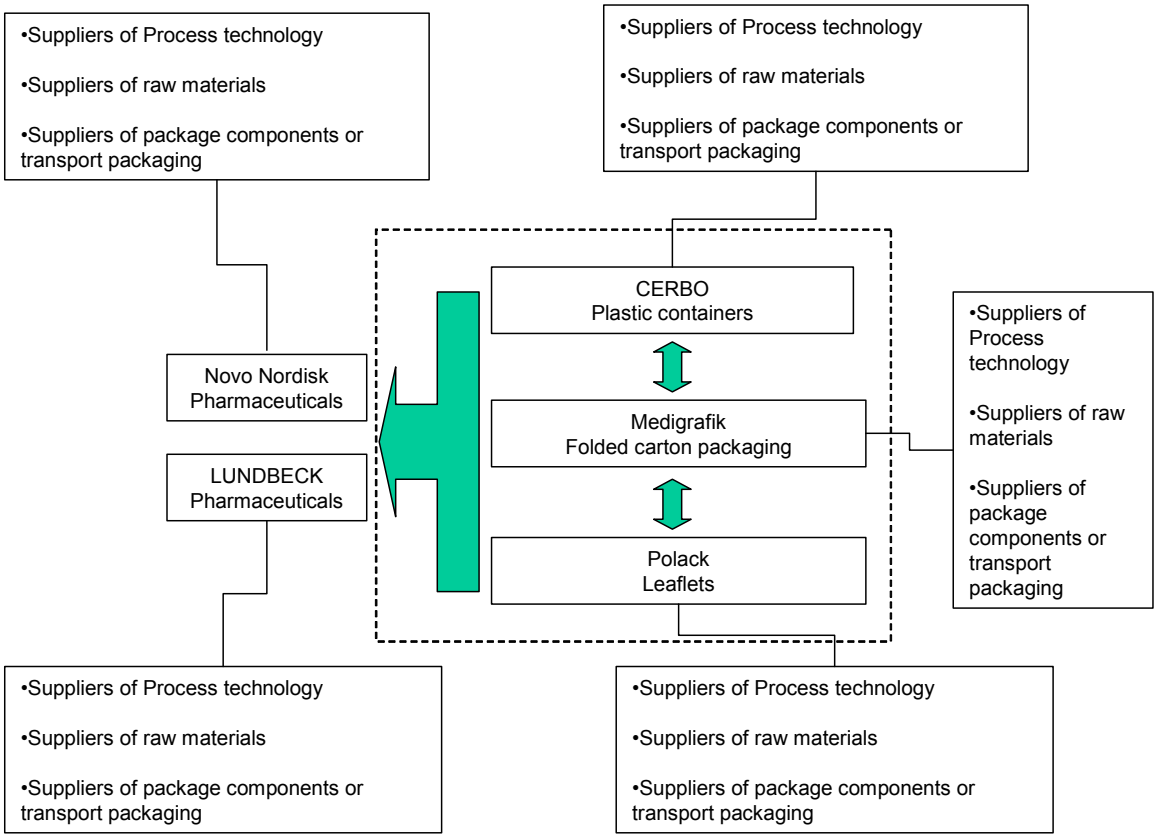
4. Production System No. 3

4.1. Introduction

This production system is reconstructed starting from the small packaging company Medigrafik, specialised in the production of printed folded carton packaging for the pharmaceutical sector. The firm is located in an industrial area a few kilometres from Copenhagen. At the time of the interview (December 1999), it had recently entered in joint venture with a medium-sized Swedish company, specialised in the production of injection moulded plastic containers. Soon after the joint venture the two companies

started talks about a merger. A follow-up interview with the manager in Medigrafik (November 2001) has confirmed the intention of Cerbo to take over Medigrafik, although it was stated that the small Danish firm would maintain a large margin of independence.

Figure 8 – Production System No. 3



Note: The dashed area represents the clusters of firms interviewed. The block arrows represents the direct links between firms

According to the sales manager of Medigrafik, the operation aimed to pull financial and technical resources in order to maintain a position in the very competitive and expanding packaging sector for pharmaceuticals. In fact, despite the two digits turnover growth, Medigrafik management decided to sell to reinforce its bargaining position *vis-à-vis* its large customers.

The suppliers of packaging in this production system have been subject of an increasing integration of production. Medigrafik acquired first Polack, and then Cerbo acquired Medigrafik. It seems that Cerbo represents at the moment the threshold size to achieve a good position in this market. However, according to the managers interviewed, the exchange among the suppliers are characterised by non-hierarchical relationship and each of the company maintains the original specialisation. The very large customers in this production system represent both a treat and an opportunity: a treat in the sense that they increasingly put pressure on the prices of the packaging, which requires increasing production capacity; an opportunity in the sense that they are the most important source of knowledge about the standard requirements that the package must have in this sector.

4.2. History, markets and specialisation of the Consumer Good Producer

The end market of this production system is represented by the two largest Danish pharmaceutical companies Novo Nordisk and Lundbeck. Novo Nordisk is the result of the merger of two Danish companies (Nordisk Gentofte and Novo Industri) in 1989. Both companies were founded in the early 1920s, and ever since specialised in the production of insulin for treating diabetes. Later, Novo became the world's leader producer of enzymes, and Nordisk specialised in drugs for the treament of haemophilia and growth disorders. In 1999, Novo Nordisk decided to de-merge in order to concentrate on their core competences in two separate businesses: Nordisk (healthcare) and Novozymes (enzymes). Together, the two companies employ approximately 16,000 people in 68 countries and markets its products in 179 countries. Lundbeck was founded by Hans Lundbeck in 1915, it has a world leading position in the research and development, production, marketing and sale of pharmaceuticals for the

treatment of psychiatric and neurological diseases. It has 17 subsidiaries in Europe and South Africa, as well as representative offices in other 16 countries.

Despite the global reach of both companies, and the presence of local packaging facilities close to the large plants overseas, packaging for the Danish market is still supplied by Danish packaging companies.

4.3. Presentation of the Suppliers

Medigrafik is a manufacturer of complete packages (carton, labels, leaflets, compact label and pressed folio) for the pharmaceutical and food industries. It was founded in 1929 under the name Christoffersen's Bogtrykkery and was located in Copenhagen. In 1995, an employee took over the management of the company. Today, Medigrafik employs sixty people in a production plant located in the outskirts of Copenhagen. It was the first graphic company in Scandinavia to get the ISO 9002 and ISO 14001 certification. In the last 10 years, the company has increasingly specialised in the production of folded carton packaging for the pharmaceutical industry. In 1996, Medigrafik took over the binding company Polack that was previously working as independent supplier. This small family business, located in the southern periphery of Copenhagen and employing fifteen people, is specialised in the supply of booklets, cutting and folding leaflets for the packaging of pharmaceuticals.

At the time of the interview, Medigrafik had just entered into a joint venture with a Swedish enterprise (Cerbo). The merger was driven by the need to overtake the financial obstacles to the purchase of new technology, and to have a better bargaining position with the suppliers of raw materials and with the customers. The merger occurred despite a consistent growth over the last years (at a rate of 20-30 per cent per year). According to the

sales manager of Medigrafik, the merger with Cerbo has not had a substantial impact on the independence of the management and production, and it has instead strengthened the market position of the two companies in the increasingly competitive sector of packaging for pharmaceutical. The Danish firm is still making folded carton packaging, while the Swedish partner specialised in plastic containers and transferred the small carton production at the premises of Medigrafik.

Cerbo is a large company in Danish terms, employing about 265 workers distributed in different production and sales facilities in Sweden, Norway, Finland, Poland (and now Denmark as well). The company produces different types of packaging for different industries, but the core activity is the production of plastic packaging -from the closures to the plastic containers and labels- for the pharmaceutical companies. In this sector, Cerbo owns several patents and trademarks and its own in-mould labelling technique, which gives the possibility to use advanced and flexible decoration and labelling.

4.4. Preliminary considerations

In this production system, the firms interviewed are supplying a market with very high standards and tight requirements, and very internationalised and dominated by few giant multinational corporations. Nonetheless, the increasing number of starts-up and new technology-based small enterprises, which phenomenon is quite spread in the Sund Region -an area that includes the East cost of Zealand and the Southern part of Scandia- provides an important and dynamic de-centralised alternative market for smaller suppliers of packaging products. In this production system, Medigrafik has integrated its own production taking over smaller complementary suppliers. Then, despite the high growth of the turnover it

decided to sell to a Swedish medium-sized company. This process will contribute to strengthen the company's position in the market of packaging for pharmaceuticals, but at the same time it will change the management of the company. Even though the type of relationship established (and the size of the new owner) will possibly enable a horizontal organisation specialised in different segments of the packaging, the small company decided to renounce to stay independently in the market and seek instead financial and technical support from a larger competitor.

5. Conclusions

The description of the activities of the firms in the selected production systems enabled to highlight their internal specific assets and the dynamic of the markets. This will be used in the next chapter to analyse the type of governance and then the type of innovation and learning taking place. As pointed out in the methodological section of the study, the change in the structure of the production systems could have been better described with a longitudinal study of several years. However, despite the relatively short time span available for the field-study, through follow-up interviews some important events that took place in the production systems have been registered.

In production system No.1, the new needs of the confectionery company arising from its expansion strategy caused the elimination from the network of two small suppliers of folded carton and one supplier of flexible packaging that were unable to compete with the larger suppliers in terms of production capacity. In the case of flexibles, size was not the only reason for selecting the supplier, in fact the confectionery company decided to choose that supplier because its higher level of specialisation and good

quality. In production system No.2, the small suppliers of the juice company have to deal with a major change in the organisation of the production, but have not been affected by that yet. The juice company has been taken over by one of the largest Scandinavia food multinationals, which is imposing a new purchasing strategy that involves mainly its daughter companies and excludes external suppliers. In this production system, the complexity of the structure is due to the simultaneous presence of very large multinational suppliers, daughter and sisters companies, and very small companies, all of them supplying a different type of packaging. However, due to their dominant position in the Danish label market, the small labels producers are not very worried about their future. The main worries come from the competition from the low-wages Baltic countries, as soon as they will achieve better quality standards. In production system No.3, the small folded carton packaging has also disappeared, but with a deliberate decision to enter in joint venture with a medium-sized Swedish plastic container company. This occurred because on the one hand, there was the need to achieve a better negotiating power with its large customers, and on the other hand, the need to pull financial resources to make investments in new technologies.

The three production systems selected are similar in regards with the type of customers supplied by the small firms. All of them are large Danish or Danish-controlled international or multinational companies, therefore with a cultural affinity with the suppliers and geographically close to them. Instead, the production systems differ from each other with regards to the markets supplied by the small firms and with regards to the process of innovation. In the first production system the high concentration of markets for food and confectionery and the big orders of these sectors require large-scale supplies of folded carton packaging. In this sector the main current

innovations are within the material of the package (flexibles and Pet bottles for example) although their utilisation is still limited. In the third production system, the market is also dominated by large multinationals but the size of the order for each package is not as large as in the food sector, therefore it is possible for a small medium-sized company to remain in the market. The use of new materials (plastic containers) is also limited in the European market and the introduction of a new package in this market is subject to lengthy approval procedures by the authorities, which can make the substitution of a supplier more difficult. Concerning the dynamic of the processes of learning and innovation, each network presented different trajectories. To understand whether the governance of the production system has a direct influence on the firms' knowledge development -and hence on the firm performance and position in the network- a closer scrutiny of the processes of learning and innovation is needed. This approach will also contribute to the understanding of the process of transformation of firms' resources into networks' resources, and to identification of the forces that make some types of networks' governance more efficient in terms of knowledge and competences development. Next chapter will deal with these dynamics and will provide the elements for discussing the structural dynamism of each production system.

CHAPTER FIVE

Power, Governance and Learning in Industrial Networks

1. Introduction

In this chapter the 'language' and 'syntax' previously developed are applied to the case study. The description of the firms' activities and of the networks' structure made in the previous chapter provides the base for a classification of the production systems according to the different forms of governance presented in chapter two. Core and ring firms are identified according to the influence and power that might be exerted on other firms. The specific assets of the individual firm are at the base of the power structures and so its "relational position" in the production system. From the outset of the thesis it was assumed that the governance structure is not static, but subject to evolution and modification. Interaction between firms, the potential knowledge development that can stem from it, together with the external shocks, such a change in the technological paradigm or markets, produce a continuous re-shaping of the network's architecture. In turn, any modification of the system's structure may affect the learning trajectory and it may lead either towards a strengthening of the knowledge base (process of upgrading) or the erosion of it (process of downgrading).

In order to verify the patterns of evolution of the networks' forms of governance over a reasonable span of time a longitudinal analysis should have been carried out. Instead, only a "snapshot" of the production systems is taken. However, through the reconstruction of the companies' history,

and through follow-up telephone interviews, it has been possible to shed light on the changes that have occurred within the structure of the networks and their effects on the single firms.

The differences between production systems are thus analysed focusing on the functional *upgrading* or *downgrading* of the single firm's activities, i.e., whether the firm specialises in higher or lower value creating activity. This process has both important theoretical and policy implications. From a conceptual point of view, it demonstrates that a change in the production system affects the learning trajectories over time, and hence it influences the relational position of the firm. This means to move the focus of the analysis from 'static efficiency' to 'dynamic improvements' of firms and production systems. The label "structural dynamism approach" given to this conceptualisation stems from the need to look at the internal dynamic of structures in their relation with the external environment and *viceversa*. The policy implications of this process are very evident as well: any instrument and measure that does not take into account this dynamism is doomed to fail. Particularly, in the case of industrial structures dominated by small firms in low-tech sectors in high cost factor countries, the focus should not only be on the acquisition of highly valuable intangible assets but also on their re-distribution among economic agents (i.e. the creation of "shared common environments").

Previous experiences can be analysed from this perspective. Recent studies on the hundred years-old shoe district in the Brenta region in Italy, has shown that the modification of the governance structure of the network is having dramatic implications for the local economy (Rabbellotti, 2001; Belussi 1999). The entry in the network of large high-fashion companies providing all the necessary inputs to the Brenta shoe producers, from the raw material to the design, is downgrading their capacity to develop new

products. At the same time, in order to remain in the network, they have to de-localise the labour-intensive and low-value activities to Rumania. As a consequence the industrial district competence at the base of its success is eroding, many companies are closing while others are showing a better performance. However, the authors of these studies unanimously agreed that there is not direct causality between high performance and remaining in the high fashion business chain, since the "best" firms were probably chosen by the high-fashion houses already before the downgrading process showed its effects.

In a system of firms the innovative capabilities might be under-exploited, but also over exploited causing stresses to other firms. Therefore, this type of analysis shows that to understand innovation is important to take into account the consequences of a change in the governance structure, following a process of restructuring. As it is important to verify the process of redistribution of the new knowledge produced with an innovation. In fact, the novelty introduced in this analysis is twofold: on the one hand, even though innovation is still perceived as a process idiosyncratic to the individual firm, its effects cannot be understood without taking into account its impact on network governance, and hence on the other firms in the system. On the other hand, a change of the network governance due to a process of restructuring has implication for the innovative capability of the single firm and hence of the whole system. The change in the quality and stock of the single firm resources implies a modification of the network's stock and quality of resources. Some production systems can have very innovative firms, but not necessarily their governance structure will automatically allow a redistribution of the benefits stemming from the innovations. This is very important in a situation of concentration of

corporate power and de-centralisation of production, as it is happening in the sectors analysed.

Next section depicts the governance structure of each production system in order to highlight the different learning trajectories, their effects on the process of innovation, and their implication for the process of transformation of firm resources into network resources. Then, in the light of the evidences from the case study, the process of capabilities' development and learning in small firms is analysed. The mechanism through which resources are created, consolidated and destroyed, according to a determined position in the production chain are discussed in section four. Section five presents the analysis of the process of innovation in the production system studied, in relation to the different governance structure. This will lead to the discussion on the governance structures' effects on the redistribution of new knowledge from the single firm to the production system, in section six. Section seven will conclude the chapter discussing the implications for the process of innovation, and the bottlenecks the firms encounter in the development of their capabilities in a dynamic and changing environment.

2. Circumscribing the governance structure

The complexity and speed of the process of restructuring of the industrial sector makes the typology introduced in chapter two difficult to apply straight forwardly. The combinations of core and rings within a production system are thus complex and numerous. In turn, this makes the source of innovation more difficult to spot. Each of the production systems under scrutiny has been subject to modification during the period of study. The reorganisation of the networks' structures was determined by four main

factors, individually and in concomitance: size (in terms of number of employees, technology (in terms of process technology available) market (in terms of consolidation, fragmentation and dynamic), and knowledge assets (skills and competencies downgrading and upgrading).

Table 3 – Governance structures

PRODUCTION SYSTEMS	GOVERNANCE STRUCTURE	CORE	SMALL RING(s)	TYPE
Production System #1	γ-Type (Core-Ring with Lead firm)	Toms	Schmidt WP Schur Polyprint	Hub and Spoke
Production System #2	β-Type (Core-Ring with coordinating firm)	Arla (Rynkeby)	Novaprint Seglemærkfabrik	Branch
Production System #3	γ-Type (Core-Ring with Lead firm)	Lundbeck and/or Novonordisk	Medigrafik Cerbo Polack	Supplier Association

Source: Elaboration from the case study.

The interviews allowed for the observation of the unfolding of the power structures regulating the functioning of the input-output systems, which enabled their complexity and articulation to emerge. The diversity between production systems is determined by both the static structural dimensions (preponderance of large *versus* small firms, low *versus* high technology, and local *vs* international firms) and the dynamic of these structures, i.e. the mechanisms that determine the creation of the assets and resource endowment of each firm (learning processes), and hence of the network. In table 3, the types of governance characterising each production system are presented. Core and rings are identified, as well as the way each production system can be represented graphically.

2.1. Governance and learning trajectories

Governance structures in the three production systems are very hierarchical, although in one of them (e.g. No. 2) the core firm has a coordinating role with limited influence over the suppliers. The main difference between the production systems is the type of links that connect the rings. Especially in the production system No.3 the production of the rings is very integrated, which has led to the establishment of stronger contractual ties. This has led to the creation of one enterprise managing the diversified supply, and therefore to a modification of the governance structure of the whole production system.

In the first production system, the large customer (Toms) is the core with a lead role in the network. At the time of the first interview there were several small suppliers of carton packaging and packaging components. The small firms' activities were highly depending on the customer knowledge of the food sector and of its marketing department for the launch of a new product (and its package). The learning trajectory was influenced by the fact that the final decision about a new packaging was always taken by the large customer. That meant also that the customer interacted in the development of the packaging. Later on, when the number of suppliers was reduced, the new packaging was entirely developed by the large supplier. This new situation has limited the influence of the core firm in the production of the packaging. The suppliers (both the large folded carton and the small flexible packaging companies) that resisted the selection process can now exercise a stronger influence on the core firm activities, although not to the extent of causing its exclusion or replacement from the network. The transformation observed in this production system is that the core is not leading as before, although it has still a strong

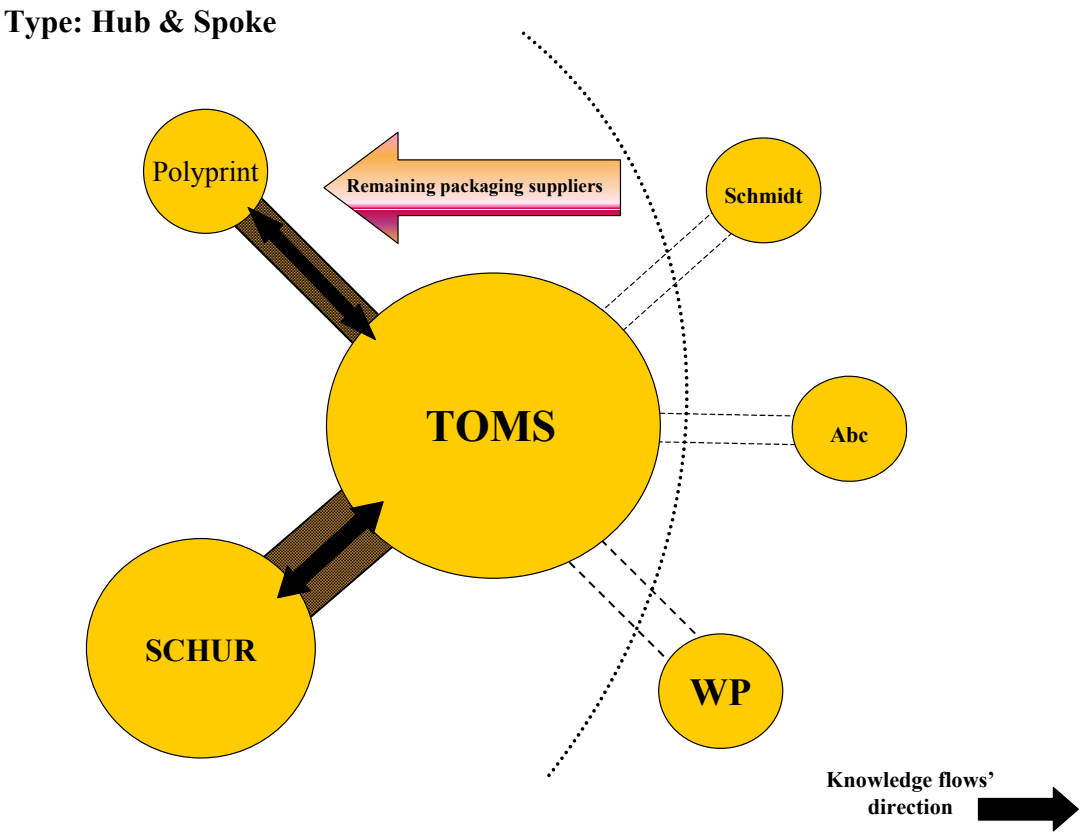
coordination role. The learning trajectory has changed from an episodic type of learning to a systematic one. Especially, the responsibility of the development of a new package is increasingly given to the suppliers. This means, on the one hand, that the suppliers have a greater possibility to influence the process of learning, by imposing their own idiosyncratic knowledge, and on the other, that the core has a higher dependence on the internal resources of the suppliers for the success of a new product. Therefore, the structure of the input-output system No. 1 is a hierarchy "γ-Type", but is moving slowly towards a hierarchy "β-Type".

The lead firm had the power to eliminate many small suppliers from the network, despite the fact that with some of them had a very old relationship. In addition, it influenced the re-organisation of the production within the large supplier of carton board packaging (introducing a new communication system). Despite the concentration of the supply of different packaging in one ring (and of large dimensions) the flexible packaging is still provided by a small supplier (Polyprint). This is due to the fact that despite the small size, it has a higher specialisation in this market niche. Again, this niche strategy seems to result positive, as far as internal economies of scale are not concerned. Finally, a further evolution of this production system will be depending on the effects of the recent acquisition by Toms of two confectionery companies in the United Kingdom. The main results in the change in the market of the core firm are i) the exclusion of small folded carton suppliers and ii) the creation of a higher value market for the remaining suppliers that specialise in the high-value operations (design and filling technology). This implies that the remaining firms are in a better market in terms of value of production and learning possibilities, while the excluded firms are relegated to a secondary market with low value added and less learning opportunities due to a higher

distance from the core, which in the long run might lead to a downgrading of their knowledge assets.

Graphically, this production system can be represented as a "Hub and Spoke", where the hub is Toms and the spokes are the suppliers of different packaging. If the size of the spokes could mirror their power of influence, then Schur will be the biggest spoke (Figure 9).

Figure 9 – The governance of PS - 1



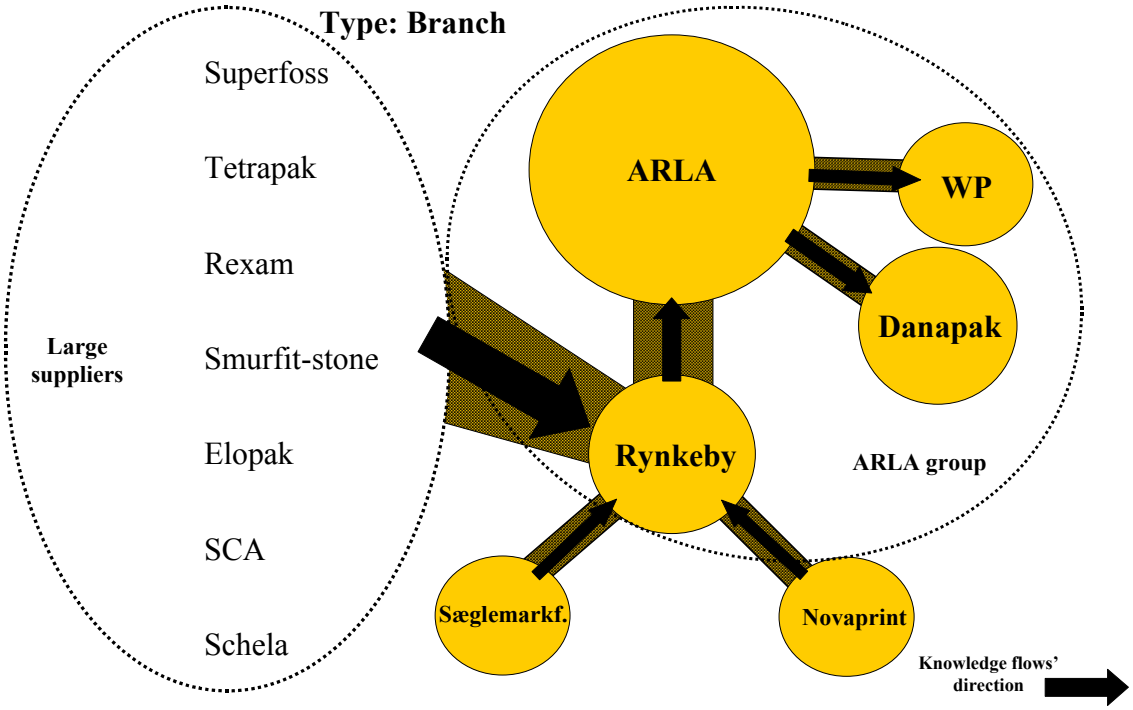
In the second production system, there is an objective difficulty in the definition of the level of dependence between firms due to the recent waves of merger and acquisitions, which effects are still difficult to evaluate. The system presents the characteristics of the β-Type, i.e. core-firm with coordinating role, although the presence of a multinational such as Arla-

MD Foods induces to think about a more hierarchical type of governance. The real core of this production system is in fact the large multinational company Arla-MD Foods, of which the juice company Rynkeby is a daughter company. However, due to the importance of Rynkeby for Arla-MD Foods's control of the juice market in the region, it is possible to consider Rynkeby as the coordinating firm of this production system. This means that, despite the core has a strong influence on some rings does not have any impact on the presence of some firms in the network. For example, the small labels companies have such a level of specialisation that they are very independent from the coordinating core. The future of this production system depends largely on the role that Arla-MD Foods will play in it. For example, it has its own label producers and has also recently acquired through Danapak the control over WP, which produces also labels. However, the small label companies interviewed have a remarkable power due to their dominant position in the Danish market and their high level of specialisation. According to them, the main treat comes from the close low-wage countries: labels compared to packaging can be more cheaply transported.

Graphically, this production system might resemble the shape of a "branch" where the flows of knowledge move up and down from the top node to the lower nodes and viceversa, passing through an intermediate node (Figure 10). The upper node should be Arla-MD Foods, the intermediate node Rynkeby, and the lower node the suppliers of packaging. Due to its better knowledge of the juice sector compare to Arla-MD Foods, and thus for the packaging of juice, Rynkeby has the role of filter of knowledge that flows from the top to the bottom and *viceversa*. If Arla-MD Foods will impose in the future the standards for Rynkeby's production,

suppliers and markets, then the type of learning trajectory of this production system might change.

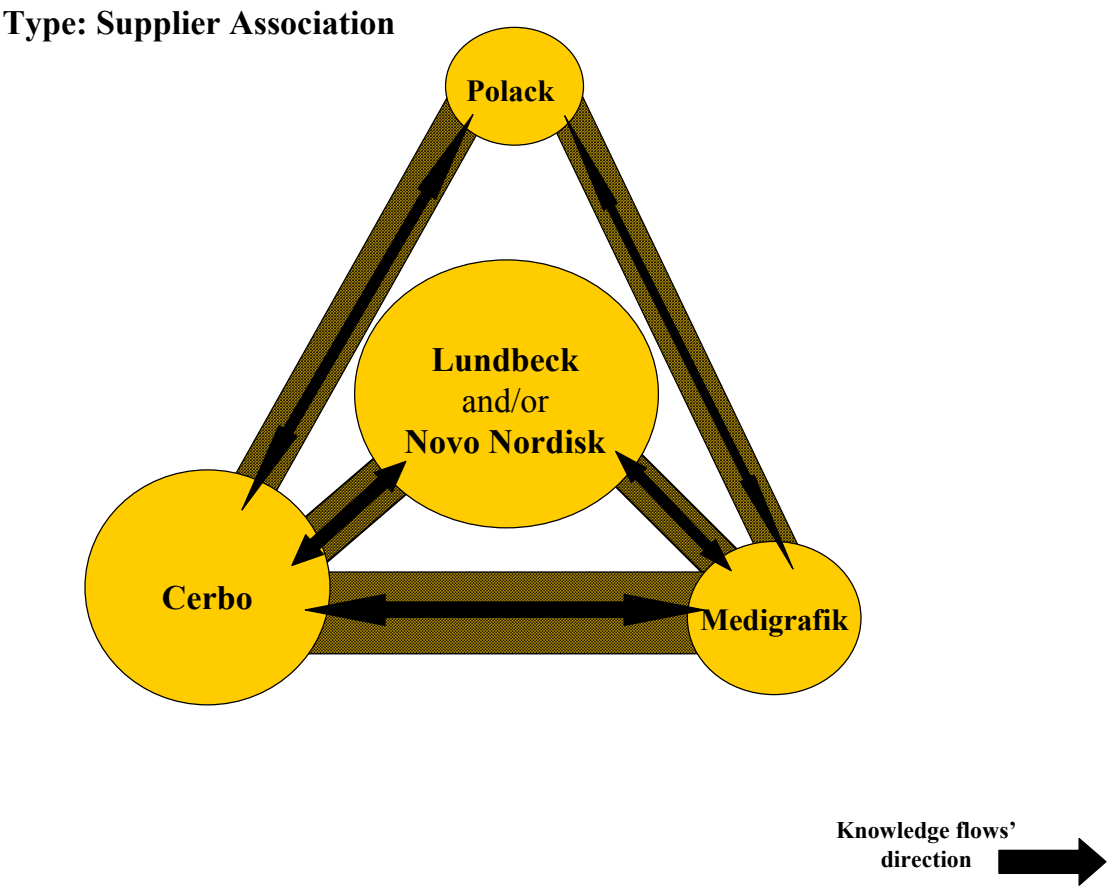
Figure 10– The governance of PS - 2



The structure of the third production system is characterised by the presence of two large pharmaceutical companies and two small suppliers of folded carton packaging and packaging material, which have been recently acquired by a medium-sized Swedish company producing plastic containers. It corresponds to γ-Type (Core-Ring with Lead firm) of the governance taxonomy. The industry of the core determines the industry requirements and the material specificities. This creates a situation of strong dependency of the rings from the core. However, the specialist knowledge of each ring, and their high level of integration of production

(each firm is providing an element of the packaging) create also strong interdependencies between the rings and the core. In this group of rings a process of vertical integration took place. The Swedish medium-sized company internalised the knowledge of the Danish small folded carton company, as this had previously internalised the knowledge of the leaflets producer. The Swedish company has acquired different level of specialisations, which is opposite to the trend towards specialising in the core competence. The dynamic of the market has pushed the Swedish company to internalise different competencies but at the same time the level of independency of the different production units provides the needed ground to keep developing the competence of each unit.

Figure 11– The governance of PS - 3



Among the graphic archetypes described in chapter two, the third production system may resemble the "Supplier Association" (Figure 11). This is a kind of Hub and Spokes characterised by easy communication between the rings. Despite the slight difference in size, the high level of specialisation of each ring puts them on an equal level. The cooperation between Cerbo and Medigrafik recalls that between Medigrafik and Polack. The folded carton packaging producer (Medigrafik) and the folded leaflets producer (Polack) started to cooperate some years ago, then they created a joint venture and then Medigrafik acquired Polack. The integration of competences has given the strength to Medigrafik to remain in the highly competitive pharmaceutical packaging market. Similarly, at the time of the interview Cerbo and Medigrafik had just created a joint venture. After few months, Cerbo proposed to take over the majority of the shares. The smaller company Medigrafik did not feel threatened to loosing independence since the integration was conceived with the aim to further specialise and strengthen the position in the pharmaceutical packaging sector, while achieving a better bargaining power vis-à-vis the suppliers of raw materials.

The next section will focus on the impact of these dynamics on the process of capabilities' development in small firms.

3. Capabilities development in small firms

At the beginning of the study, in the first production system the frequent exchange of ideas and interactions between the suppliers and the large customer helped, for example, to develop new design capabilities in the small firms by pushing them to purchase and use new digital printers. In this situation there was, on the one hand, a customer providing the main

ideas and the requirements needed for the material, according to the market demand and the sector regulations. On the other hand, there were the suppliers transforming these ideas into a finished packaging. In some cases the large confectionery company grouped all the suppliers of packaging and packaging components to develop an entirely new package, such as for example in the case of the Christmas gift boxes that contained several chocolate products (and hence several package components produced by different suppliers). In Nonaka's terminology, new knowledge was created through the re-combination of knowledge frames and knowledge basis, spread all over the production system.

However, from the study emerged that except from this specific example of four suppliers coordinating their knowledge to produce an entirely new product, establishing an important collective learning process, the small suppliers have usually had a one-to-one interaction with the customer. The small suppliers of this network exploited the large company's knowledge about the food industry and improved their knowledge about materials and design. This pushed them to upgrade constantly their capital equipment as well. With the exclusion from the network, small folded carton packaging suppliers faced a decreasing in the learning process. The elimination of the small suppliers implied that the transfer of knowledge is now canalised within one supplier, of larger dimension, which is increasingly responsible of design, material and packaging technology development. The re-organisation of production was due to the need of the large customer to have a more coordinated and rationalised supply of folded carton packaging. This happened despite the fact that the two small suppliers were equally innovative and endowed with state-of-the art technologies. Instead, the small supplier of flexible packaging supplier was not replaced despite the fact the chosen supplier of

packaging could produce the same flexibles packaging as well. Therefore, the restructuring process of this production system cannot be related only to a problem of economies of scale. Therefore, in this production system, both size, quality and market factors played an important role in the selection of the suppliers. The need to avoid a complete dependency on one supplier only, and the quality of the products enabled the small flexible packaging firm to remain in the network.

Most interesting is the way the small suppliers of folded-carton packaging that were excluded from the network have reacted. One of the companies was taken-over, another one was closed down, while the third had purchased new printing technologies and entered into another market (packaging for pharmaceuticals). In the third company the diversification of production has contributed to the development of new capabilities. The capabilities of the second company that closed down has disappeared from this production system, while the company that was taken over has partly diversified its own production, although the main change is in the organisation of the production which is now decided by the mother company.[107]

Compare to the previous case, the development of the small firms' capabilities in the second production system occurred less through cooperation between core and ring and more through sources of knowledge external to the system. In particular, the small label firms have very large customers with which have interactive processes. In this way they achieved a high degree of specialisation that ensures them a considerable role in the network. Taking also into account that in the labels industry innovation is based on little improvements of the design, the ability to create new labels'

[107] The capabilities of the company that closed-down did not really disappeared if the skilled workers found a job in another similar industry.

concepts is central. One of the label company interviewed developed the idea of “campaign labels”, which consists in the design of different labels for the same product to be sold during a limited period of time. This implies a high flexibility in the process of gluing and high skills in the process of designing. The combination of organisational and product innovation enabled to remain in the network despite the competition from the geographically close low-wage countries, such as Poland and the Baltic countries. In this case, the niche strategy has given positive result, though they feel that the risks connected with the internationalisation of production and the increasing price squeeze can put at stake their future survival. From the interviews has emerged that the type of collaboration existing within this production system does not lead to the creation of shared common environments. Rings do not co-operate among them and the small label firms rely mainly on other and larger customers than Rinkeby to develop new ideas. Rynkeby is less important than the other companies for the development of their capabilities.

The small firms in the third production system are highly specialised and act as very independent units in relation to the core of the production system, despite they become merged into one company. Knowledge development occurred both through the interaction with the core, while among the rings it is unclear how different materials’ knowledge is integrated in each firm production. This sector of the packaging industry is particularly subject to the stringent quality and hygiene standards set by the pharmaceutical industry. In fact, each modification of the packaging (or the substitution of a supplier) requires a re-registration of the package, which means lengthy and expensive procedures, and longer time-to-market. Therefore, in this sector, the functional part of the design is more important than its aesthetic appearance. The increasing complexity of the demand in

the packaging for the pharmaceutical industry requires the sharing of all the information that are needed to respond the standards necessary to the production of a packaging. The suppliers in this production system are largely dependent on the industry requirements. In the plastic containers production, the process of adaptation of each other knowledge base is very evident. For example, the modification of a plastic container requires the construction of an entirely new mould. This means that the internal knowledge frames of the firm have to be recombined each time in order to get as close as possible to the initial request from the customer. Internally, interactions between smiths and production engineers on one the hand, and sales managers on the other, represent the processes through which this recombination of the knowledge base leads to a new solution. Customers, though very demanding, will adapt to what is possible to produce with a given technology and a given material. In this way, their knowledge base is enlarged as well, and diffused to the suppliers producing other packaging components. In this production system, the suppliers have found a way to gain market share by specialising in a niche segment of the packaging industry. Market requirements played a substantial role in the transformation of the network and its 'solidification' through tight contract ties. The proactive strategy of the suppliers, choosing to specialise in the pharmaceutical packaging, provided them with high annual growth rates and secured the near future.

4. Rents creating and destroying activities

The reorganisation of production activities has important repercussion on the distribution of power and on the creation of rents. For example, in the first production system the design of new packaging, a central element for

the marketing of a product is now completely delegated to the large packaging company. This implies that the end-market firm is withdrawing from that intangible phases of the value chain, such as in design (in which there is an increasing concentration of rents), whilst the packaging firms is investing more on the design and on the service functions. However, downgrading towards activities that are probably less profitable is in line with the strategy of expansion and concentration of the core firm in the confectionery sector. Through the acquisition of competitors in the home and in the UK markets, the firm is specialising in the manufacturing of confectionery and is creating high entrance barriers. Therefore, it can downgrade on the intangible phases of the value chain while upgrading on the production sphere yielding both *Ricardian* and monopoly rents. The large firm supplying folded carton packaging is instead undertaking a strategy of specialisation in non-productive phases, such as design and services to manufacturers that are using their packaging and filling machinery.

This last point raises important issues for low-tech industries and for small enterprises that do not have the financial capacity to make such investments in developing their own technology. As pointed out by Teece, on the one hand only focusing on design is risky because imitation is easy, and even where is not "it is difficult to price intangible assets whose true performance features are difficult to ascertain *ex ante*".[108] On the other hand, the process of concentration and the increasing need for the producers of folded carton packaging to achieve economies of scale are such that only intangible assets can provide smaller firms with a competitive advantage. Furthermore, small suppliers of folded carton

[108] Teece, 1988, p. 215.

packaging are threatened by the introduction in the market of new types of packaging such as the flexibles. Innovation in material in this case is destroying consolidated rents for many small suppliers, despite they are specialised in a product that is still dominating the market but subject to the pressure to achieve higher scale economies.

In the second production system, most of the packaging firms are very consolidated large players that in the last years strengthened their positions in the development of new process technology and new packaging materials. In this case the juice company does not have the possibility to improve its knowledge about packaging or to develop new kind of packaging. Also in relation to the small suppliers of labels, the juice company does not have much influence in the development of new types of labels. Innovation in the packaging material (such as for example the introduction of plastic bottles) is involving more the small labels producers companies than the juice company. The small labels producers are small in size but have a dominant position in the Danish market and are very specialised. In this production system rents are created among those rings that are fast in grasping the innovation introduced by a large packaging producer, instead of by interacting with the core. In the future, the acquisition from Arla-MD Foods will likely enable the juice producer to have a better negotiating power vis-à-vis the large suppliers and then impose its own knowledge about the juice market and juice processing to the rings. Also, in relation to the small producers the direct intervention of Arla-MD Foods will give more power to the juice company, which will either create new assets or erode their rents through substitution with other labels firms.

In the case of the third production system, the integration of the productive structures of the rings implies that new rents are yielded and

distributed over the whole production system each time there is a development of new packaging material or of the technical characteristics of the packaging (technical design). The rings of this production system are undergoing a process of centralisation, but keeping the specialisation in their core competence. Compared to the other production systems, this represents the most open and conducive environment to knowledge sharing. The common strategy and needs facilitate horizontal knowledge flows. This type of network, in this specific sector, is in fact leading to a consolidation of Ricardian rents over the production system, due to the integration and specialisation strategy of the firms involved, while monopoly rents are acquired through higher internal economies of scale and scope.

5. The dynamic of innovation

Major product and process innovation in the packaging sector stem largely from the big suppliers. Nevertheless, in the three years previous to the first interview the small firms have undertaken important changes in both their process technologies, by purchasing new machinery, and in their products, by changing incrementally the design. Printing technology was a central innovation in these firms and all the small firms interviewed had their own digital four colours printer. Raw material (paper and plastic) development come from the upstream industries, but its different applications to the packaging industry is instead a process internal to the packaging producers. In this field large enterprises have more opportunities to innovate since they have large R&D laboratories. Another structural disadvantage for small firms is that they cannot offer a whole package –and its special filling machinery, plus all year round assistance service, plus design and material

development- to their customer. The process of concentration of technological and design rents in the large firms enable them to de-centralise their production to small local producers through subcontracting and license agreements. The study has shown that the small independent firm cannot compete with this process. The restructuring of the sector is changing the learning trajectories and large suppliers play a pivotal role in the development of design, material, and the related filling system. As pointed out by Jelinek (1996), this trend reflects both the importance of scale economies in mature industries and the high entry barriers in mature technologies due to incremental hidden innovations, as well as increased focus on core competencies, which leads to integration of the activities. That is why the design of the packaging is increasingly integrated in the function of the supplier.

Traditionally, the customer's main influence was on the design of the packaging (due to the knowledge it had on its market), and it thus depended largely on its marketing departments. The suppliers' R&D department was instead developing the technical aspects, such as shape, material, opening systems, caps and closures' characteristics. Today, the situation is changed, and so the customer-supplier relationship has changed as well. The major problem that emerges in this new phase of customer-supplier relationship is the change in the decision-making process. Some customers claimed during the interviews that sometimes they have to make a "buying marketing" to convince the large supplier of their good ideas. The problem with big supplier is that they tend to impose the knowledge possessed, and are more reluctant to accept lengthy and difficult processes of small adaptations, for the same price. In some other cases, the customers related the lack of interaction to the limited size or to the excess of specialisation, which locks small suppliers into idiosyncratic routines. Also, customers explained the

failure in the cooperation with the fact that the suppliers' lack of an open 'knowledge-sharing' attitude. This is another important element that is too often taken for granted. As outlined by Whiston, the lack of willingness to cooperate may represent an enormous obstacle to the process of learning despite the need and demand of learning of each firm (Whiston, 1996).

Although in the packaging firms interviewed both process and product innovations have been incremental, and mainly encompassed the modification of existing designs and technologies, the introduction of new materials has produced more radical implications, involving the modification of the whole production chain. For example, the recent introduction of the plastic and flexible containers is marking a significant change in the packaging sector, in both the food and the pharmaceutical industries. The small firms in the production systems were not able to shift type of production, but instead changed market to survive. If the minimum scale threshold will be similar to that in the food and confectionery sectors also in the pharmaceutical sector, then the small firms will have to find another niche. However, that is not the main issue tackled in the study since the markets were considered as the independent variables and their change is not linked to the change in the assets of the firms and the power structures but viceversa. Therefore, looking at the current situation in the production systems analysed the small firms either have "voice" and interact with the other firms to absorb the effects of an innovation, or are doomed to "exit" if the effects of the innovation are not sustained by the creation of new assets.

5.1 Sources of knowledge

In the production systems analysed, product and process innovation reflects the general trends in the industry: Large suppliers are more

integrated in the strategic functions, intervening on both the design and the process development sides. Small suppliers are instead trying to find niches and are hoping that the de-localisation of production will take a while before destroying their market segment. In the cases analysed, the interactive learning starts when at the very beginning of the relationship the customer introduces to the supplier the problems related to the packaging of a certain product. Then, when the supplier firm sends back the prototype that can be closer to what the customer firm was expecting it starts a circular flow of knowledge. This flow is both strategic and reflexive, although the possibility to negotiate and to consider all the factors at hand depends very much on the power of each firm. The development of a new product represents a process of "rationalisation" of customer needs and supplier knowledge. From one side there is a company transferring knowledge about market needs and production capability, and on the other there is a supplier transferring its knowledge about the feasibility of production with the available technology and material. In principle, supplier and customer are both recipients and transferors of knowledge. The aspects of the process of learning analysed in this study were related on the trajectories that the learning might have taken. The analysis of the individual firms innovative activities showed that different governance structures affected the learning processes, and hence the ways production units may acquire, absorb, integrate and transfer the knowledge needed to produce a given good. Several authors (Saviotti, 1998; Arora and Gambardella, 1994; Teece, 1986) have highlighted that these mechanisms depend on the type of knowledge, existing and new, and on the institutional setting in which the learning takes place, i.e. the communication channels. To these factors, Whiston has added the "willingness" of the parties to exchange the relevant knowledge (Whiston, 1996) and I have added the

factor “access” to different sources. In every production system analysed, although small suppliers represent an important source of knowledge about materials, techniques and technologies, the customer is the key source of knowledge. Each firm is in theory responsible of its own stock of knowledge and of its ability to acquire it drawing from the different sources. Yet, the structural limits (limited human, technological and financial resources) that characterise small firms represent an obstacle to the possibility of learning from many sources. Small firms have then to concentrate the efforts on specific sources of knowledge, especially externally.

5.2. Learning trajectories

From the cases emerged that markets represent a main source of knowledge. In dynamic markets, such as pharmaceutical, in which firms have to cope with short life cycle products and/or high degrees of competition, small suppliers rely mainly on the customer as reference source and have a reactive attitude towards innovation. In less dynamic markets, small firms take a proactive attitude towards innovation: externally relying mainly on sources such as competitors, associations of producers, and internally on the design department. However, not only the market dynamic is responsible of the learning dynamic, but also the position that the firms occupy in the production systems’ architecture. A good ring position in the production system facilitates interaction with the customer and reduces the “cultural” distance existing between powerful and less powerful firms. Learning is also affected by the attitude towards the exchange of knowledge crystallised in the network. In some cases, the kind of relationship established led to a conducive learning environment,

while in other case a looser relationship between suppliers and customers led to failure or to a less open learning environment.

Innovation in all the production systems analysed is based on this principle of interactive learning through the establishment of a knowledge circular link, but the sources of knowledge and its exchange have taken different avenues. Common to the first and second production systems, the modification of the design is the main type of innovation. As pointed out by Hansen and Serin in their study on the low-tech industries, the modification of the existing products is not perceived by the people in the firm as innovation development, but as design and customer adaptation of the product.[109] Instead, design modification represents a very important source of advantage and value in the packaging for food. It is one of the elements that enable high factor costs countries to remain specialised in the low-tech industries.

In the first production system, process innovation in the folded carton packaging system is a direct consequence of the internal activity of the only supplier of packaging. Previously, when there were other suppliers of folded carton packaging, the modification of the products was "negotiated" and the following modification of the computer software, or also the purchasing of brand new machinery, was thus the result of the interaction between customer and suppliers. In the second production system, the power structures work against the establishment of an open 'knowledge-sharing' environment. The customer has the chance to contribute to the product development only with the small suppliers of labels. However, they are very specialised and not very depending on the customer's knowledge. In the third production system, innovation in the packaging and the

[109] Hansen and Serin, 1997, p. 186.

introduction of new materials depend largely on the requirements imposed by the end market firm. Due to this industry-specific constraints' major inputs come from the large pharmaceutical firms, especially in terms of knowledge about standards and markets trends, but the way on how to achieve these standards requirements is necessarily shared by each firm of the production system.

6. From firm capabilities to network capabilities

An important aspect in the analysis of the process of innovation is the redistribution of its benefits across the firms of the production system in which the innovative firm operates. Both the knowledge stemming from autonomous or systemic innovation can be shared, although the systemic innovation will have more destructive effects on those firms not able to catch-up and therefore will reduce the number of potential adopters. As pointed out in chapter two, a mechanism that enables the sharing of knowledge among many actors is the process of collective learning and that this takes place only if the two conditions of access to knowledge and willingness to share it are respected. In that case there is the creation of a "shared common environment", in which the knowledge of the innovator is redistributed and crystallised in the production system to the advantage of all the firms in the system. The creation of a "shared common environment" leads to "cognitive external economies" providing not only stability and varieties, but also access and positive attitudes in the network. In the case study analysed knowledge sharing and transfer are based on one-to-one interactions, and very few exceptions involved more parties in the learning process. Collective learning is limited, despite the "cultural"

heritage shared by these firms, being all of them Danish owned, and by being geographically relatively close to each other.

In few cases the process of innovation has lead to the redistribution of the new knowledge produced. In the first production system for example, innovations in the core firm industry, such as for example the introduction of a new confectionery product was shared with the packaging producers, which needed to know about the new product characteristics, in order to select the right raw material. In other cases knowledge is not necessarily shared. For example, in the development of a new package by the large folded carton packaging company that remained in the network, the knowledge embedded in the design and process technology does not need to be shared with the food company. In the specific case of production system Nr.1, by choosing a bigger player that is able to provide the whole packaging solution the core firm limits itself to lease or buy the filling machine, while providing little inputs in the design of the product packaging. Each time a new packaging is developed, it is the packaging company itself that upgrades the filling or sealing machine. The knowledge about the new products and packaging might then be transferred to the other firms that belong to the production system, such as for example the suppliers of sales and transport packaging material.

A different example of sharing knowledge among several actors is production system Nr.3. In this case, the pharmaceutical companies need to transfer the knowledge about the industry standards to the suppliers. Then, among this group of suppliers the shared common environment is created, although it should be taken into account that these firms are by now integrated in one company only. In production system Nr.2, instead the presence of very large firms and the independence of the small label producers from the core company do not seem to create the conditions for a

sharing process. In this case, the single firms' capabilities remain within the firm and the network, as a whole, does not have particular benefits.

7. Conclusions and implications for the process of innovation

The analysis of the cases has shown that the differences in the forms of governance are determined by both qualitative and quantitative factors. However, major emphasis should be given to the role of the qualitative factors, i.e. the specific knowledge assets of the firms, and in particular tacit knowledge. These assets are responsible for the creation of both the core and rings within the production systems, which is why interactive learning between the relevant actors, such as customers, competitors, suppliers, and in few cases the institutions, is central in the development of these intangible assets. From the analysis, it has also emerged that the upgrading of the knowledge assets and the learning trajectory are dynamic processes that depend upon the power structures present in the production system. The qualitative assets give the firm a specific relational position and the governance of the network will influence the dynamic of this position. Once having identified the governance structures and the type of learning, the analysis moved to study the process of transformation of the individual firm's capability into the network's capability. This is particularly important in the case of small firms in the low-tech sectors that suffer from structural deficiencies and cannot upgrade their technological and technical skills without the support of the core firms. Situations of negative dependency and hierarchical forms of governance are not *per se*

an obstacle to the development of the small firms if they lead to the creation of shared common environments.

From this perspective, the main conclusion is not that innovation can result in the exclusion of some actors from the system (that will always occur) but that the absence of sharing knowledge environments will reduce the knowledge base of the whole production system. To avoid such losses it is necessary to develop learning trajectories leading to the co-development of the resources available in the production system. The process of downgrading is functional to the specialisation of some firms, such as for example the large customer in the confectionery industry that is withdrawing from the development of new packaging, but is dis-functional to others and in particular the smaller ones. In the small folded carton packaging companies the exclusion from the production system has meant either entry in a lower market, or total disappearence from the market. Similar trends can be forecast easily in the second production system if the production of labels is moved abroad or is internalised by the mother company. Finally, when looking at the third production system there is a different explanation of the process of knowledge upgrading. The creation of a shared common environment is achieved by joining forces, initially through a joint-venture, and then by merging into a single company. This has been successful so far, and it will be worth investigating how long the internal hierarchy, which is now quite flat, will be kept, despite the ownership being in the hands of a single person.

CHAPTER SIX
Conclusions and Implications for Future Research

1. For a Political Economy of Production Systems

The instability and uncertainty deriving from the process of globalisation and the increasing dependence of production on market fluctuations are reshaping the production landscape and the internal organisation of production systems. Markets and firms are created and destroyed in a restless movement, although this is nothing new. Yet, it is not a neutral process since market relations are essentially power relations.[110] The study has in fact shown that the current process of restructuring is not based on productive flexibility (large and small firms are equally flexible today) but on power structures.[111] This has implied, on the one hand, that the firm is not a sufficient level of analysis for studying industrial dynamics, and instead a more systemic approach is needed. On the other hand, to understand production systems' dynamic the whole set of relations among firms should be taken into account and in particular the quality of links between the firms.

The study has also shown that there is not one model of production system which is best able to reap the advantages from the current process of industrial restructuring. Already in 1983, Frank Wilkinson pointed out that:

[110] Wilkinson, 1983, p. 420.

[111] It is not enough for a small firm to rely on the flexibility of its labour and its ability to shift from one order to another, in a relatively short time. This kind of flexibility has been achieved by large firms with the introduction of new organisational and process innovations. Crucial for small firm is to combine the flexibility with the acquisition of a good position in the value chain.

> "While it is possible to draw sets of blueprints for the relations of production, market relations and the social and political framework for all conceivable productive systems, this does not mean that a choice can be made between different systems, since each system is the unique outcome of its own history. The way a system changes involves a complex interaction of technical, economic, social and political forces which itself takes place in historical time. The interesting questions, therefore, are not about choices between techniques or the achievement of equilibrium but about the conditions leading to the emergence of different productive systems and the terms on which systems co-exist."[112]

There is a wide variety of production system and the attempt to systematise it has provided a useful tool for further analysis. The focus on the processes of learning and knowledge development was also central to the study of small firms in the low-technology sectors. The study has shown that different governance structures can have different results in terms of learning and upgrading of the network capabilities. Likewise, similar governance structures can have different effects in different markets. Furthermore, even if the market and the form of governance are the same, it is both the willingness of the actors to share and the capacity to access that determine the learning trajectory of the production system. Perhaps small firms in selected industries have little possibility of access, due to their structural deficiencies, but a stronger willingness of the other firms in the production system to coach them in the process of learning would have helped to solve this problem. Also, the analysis has shown that

[112] Wilkinson, 1983, p. 421. In this article he is arguing about production systems although he uses the terms productive system in an ambiguous way. Lawson in 1999, referring to Wilkinson's article, instead points out to the difference between the concept of "productive system", i.e. the set of productive relationships on a given territory and "production system", i.e. the set of input-output relationships *à la* Wilkinson, Cf. Lawson, 1999.

the loss of resources in a production system, due to the disappearence of a small firm, can affect the other firms as well. Despite the restructuring process and the globalisation of manufacturing production small firms are trying to implement different strategies. Innovation is one of those, and certainly an important one, but as the next section will show, innovation dynamic is subject to many factors and it may be less strategic and reflexive than expected.

The need for a *political economy* of production systems arises from these considerations. The study of the interrelations between markets, the power structures, and the process of learning opens up to the possibility of a new methodological and political interpretation of industrial dynamic. Therefore, policies aiming to improve production systems, and hence provide the frameworks for eliminating the bottlenecks affecting the upgrading of firms' capabilities, should take this complexity into account when analysing the consequences of the restructuring process for the local production systems.

2. Empirical results and main conclusions from the case study

Although longitudinal studies are preferred in qualitative research on inter-firms relationship, this study provides enough stylised facts to draw implications for current research into industrial dynamics. In synthesis, the study shows that:

- The innovation dynamics of the single firm needs to be studied from a systemic perspective;

- The “structural dynamism” of the systems, i.e. the intertwining of the resources development and the governance structures in given markets determines the performance of the firms involved;

- Innovation in small low technology firms is subject to the quality of the relationship established with the other firms of the network;

- Intangibles are increasingly strategic for small firms in the low-tech sectors, although in some industries (such as in folded carton packaging) productive capacity is increasingly decisive;

- Very hierarchical networks are less incline to redistribute the benefits from the learning processes in terms of knowledge sharing;

- Lack of knowledge sharing among networks’ members can lead to the exclusion of some firms from the network;

- This in turn produces an erosion of the networks’ knowledge base and the creation of dual markets within the same productive sector;

- The dependency between firms in the same network, regardless of the internal level of hierarchy, is not necessarily negative. Firms can still learn despite a high dependency from the core;

- Collective learning is limited, despite the “cultural” heritage shared by the firms. Only in a few cases are “shared common environments” created;

- Large firms are increasingly flexible and the risk associated to stock-keeping and payment delays are transferred to the small firms, which in this way finance the large firms;

- Innovation in small firms is an increasingly reflexive process that takes into account the expectations of the partner but is less strategic since it depends increasingly on the power structure;

- The opposite is the case as large firms' innovation is more strategic than reflexive, since they pay less attention to the needs of the small firms.

The thesis has also shown that there is not an epochal shift from large enterprises to small enterprises. Instead, as pointed out by Belussi (1999), there is a "possible co-evolution of differentiated structures", together with a process of "economic re-centralisation" due to the necessity to have a minimum organisational threshold and to the reduction of coordination costs with the introduction of information and communication technologies.[113] In this new complex production regime new interdependencies are continuously created and are subject to continuous change.

The study of the single cases has highlighted that market fluctuations and the strategy of large firms induce a process of inclusion and exclusion. The result is a dual structure within similar industries. This will probably always occur in a capitalist system, but the most important aspect is to

[113] Belussi, 1999, p. 731 and p. 733.

understand how inclusiveness can be stimulated. The explanation was based on the assumption that the firms that remain in the network have the opportunity to upgrade their capabilities, while those that are excluded are relegated to a secondary market. Gaining a position in a high value markets gives a certain prestige and regularity of orders. While the lack of integration in the network produces negative dependency, imposition of tight delivery conditions and timing, and eventually downgrading of functions, which in the long run means a reduction of value added and erosion of knowledge. The problem investigated in the research lies in the identification of these dynamics and their effects on the small firms.

3. Power and influence shaping the governance of industrial networks

The concepts of power and influence have been used to explain the governance structure and learning processes of production systems, which dynamics are responsible of the development trajectory of regions and countries. Power and influence determine the condition of dependency between firms. Their creation and distribution is not a static process, but it is a process changing over time and depending on the patterns of internal and external economies of scale and scope. Internal economies of scale, as in the first production system, have operated as a market mechanism to eliminate the small folded carton producers from the network. At the beginning of the study, the relations between the core and the rings were very good and common product development took place in several occasions. Despite this, and although the smaller suppliers were very specialised and equipped with advanced printing and sealing technologies,

they could not compete on the capacity side -a central factor in the new strategy of expansion of the core company. In addition, the introduction of new materials in the packaging industry, such as flexibles and plastic containers, has affected the capability of the small folded carton producers to remain in the network. In this production system, the presence of only one folded carton packaging has reduced the power of the core company, which is in fact considering to enlarging its suppliers portfolio again. In the second production system, the presence of high internal economies of scope and scale reduced the ability of the juice company to have an independent market policy towards the suppliers, both the small and the large ones. This was also due to an "undefined" strategy of purchasing between the mother and daughter companies which represented the core. The company producing juice and marmalade relied on the mother's company strength to negotiate with the large suppliers, but rejected its support in the joint development -with the suppliers- of new products and types of packaging to avoid interference in the production side. The small suppliers of this production system are very specialised and independent, and the juice company is not a strategic customer for them. An interesting aspect of this production system is that the mother company of the core has acquired a small packaging company previously operating in the first production system, and very specialised in the production of labels as well. At the moment of the writing, the effects of this acquisition on the small independent labels' producers are not visible. In the third production system, the small suppliers are increasingly integrated into one productive unit. The growing specialisation in the packaging for pharmaceuticals and the need to achieve higher economies of scale pushed them to enter a joint venture. However, it is important to underline that the "contractual" aspects (equity versus non-equity contracts) are not determining factors in the

establishment of a good learning environment. Also, for the firms of this production system the elimination of the transaction costs related to the exchange and share of knowledge was achieved with the creation of a 'shared common environment' within a single company.

As outlined in Harrison and Storper (1999), the problem for the process of innovation and learning does not lie in the pattern of internal and external economies of scale and scope, but on the quality of the relationship established among the firms. Especially for small firms, the connection to large firms can be regarded as a source of advantage only if there is an active participation in the learning process. In other words, small firms, although dependent on the knowledge and the economic power of the multinational/large internationalised firms, can learn how to solve new problems and to improve their production capability if the large firms engage in a more open interactive learning with them. This is the meaning of the creation of "shared common environments". In the small firms analysed, innovation is the output of a continuous process of adaptation and modification of products' designs and process technology. The large customers are the main source of knowledge. Design and the process of adaptation of products to the markets become the central elements. This evidence also confirms that the upgrading of the small firms' products depends on the type of industry. That is why, in the analysis, a strong emphasis was put on the learning factor as a mutual and shared process. In a situation of increasing cost driven supply arrangement,[114] the passage from bilateral subcontracting to bilateral or multilateral partnership among firms is a key factor in the upgrading of the systems' learning function.

[114] Sakai K., 2002.

4. From firm-based to network-based processes of learning

The research has also pointed to the limits of the literature on innovation and knowledge development in focusing on the creation of competitive advantages at the level of the individual firm only. This perspective failed to take into account the redistribution of the knowledge developed in a given production system. Even though firms' innovative activities remain an internal and idiosyncratic process, they reflect the interaction with the external environment. More recently, network relationships are increasingly considered as network resources (Gulati, 1999). Accordingly, networks can provide both the "benefit of resource sharing, allowing firms to combine knowledge, skills, and physical assets" and the "access to knowledge spillovers, serving as information conduits through which news of technical breakthroughs, new insight to problems, or failed approaches travels from one firm to another".[115] The important contribution of this kind of study is the emphasis on the type of linkages, i.e. the presence of direct ties, indirect ties and structural holes which enlarge the spectrum of possibilities for the firm to have access to different source of knowledge, but also to be more opportunistic.[116] The "redistributive" effects of the learning process (as a cumulative and not individual process) gain centrality in the passage from firm to network resources analysis. As Garud (1994) pointed out, the issue is not related to the necessity to establish vertical or horizontal interdependencies, but on the sharing of the knowledge embedded in the relationship.

[115] Gulati, 1999, in Ahuja, 2000, pp. 427-428.
[116] See for example the study of Burt, 1992 on the social structure of competition, quoted in Ahuja, 2000.

The process of sharing and redistributing is linked to the individual interest of the firms and power structures, but also to the ongoing processes of concentration and decentralisation in the industries. For example, the concentration in the packaging industry has led to the integration of process and product technologies in fewer firms. This means that the knowledge produced innovating, for example, the closure system or the material of the package is kept within the same firm. In this sector, those firms that do not have the capacity to integrate process and product development have a limited capacity to survive. Internalisation of competences creates knowledge monopolies. Instead, the fragmentation of the operations in the supply chain might lead to the opposite result of facilitating the redistribution of the knowledge produced elsewhere. Nevertheless, keeping a monopoly on knowledge does not mean to exclude firms from the learning process, if the firm repository of the relevant knowledge systematically transfers it. In fact, knowledge does not flow automatically and independently. Wilkinson (1983) claimed that "in both the organising and structuring of productive relationships there are two distinctive elements: mutual interest and relative power".[117] Lack of interest is related to the strategic choices of the firm, while lack of power may represent a structural deficiency. That is why, especially for the small firms, not equipped with highly developed research and development laboratories, it is so important to stay in the dynamic learning networks. Nonetheless, learning needs to be:

a) Sustainable with the resources available in the production system;

[117] Wilkinson, 1983, p. 417.

b) Redistributive, i.e. leading to the creation of "shared common environments";
c) Involve relevant knowledge and not just generic one.

5. Sustainable learning in industrial networks

Of the points mentioned above, the sustainability of learning is the most relevant regarding the aspect of access of small firms to processes of learning, the second point is related to the aspect of willingness of the transferors, while the third is concerned with the quality of knowledge. Access and willingness represent the two elements necessary to fulfil the creation of genuine process of collective learning.

To understand the problem of access to relevant knowledge in small firms it was necessary to resort to the writings of Arora and Gambardella (1994) and Dosi (1988) on the absorptive capacity. According to them, even if one firm is willing and interested to transfer an important "piece" of knowledge to another company, a certain capacity of the recipient to absorb it is needed. For example, the small folded carton companies of the first production system that were excluded from the network were largely dependent on the customers' knowledge base in the development of the design. Still, they had the capacity to adjust the design to their own production capability. In those cases, the dependency was not negative since there was on the one hand, willingness and interest of the customer to undertake the exchange and, on the other, the ability to absorb the inputs. In the other production systems, the small firms have better access to the relevant knowledge. In production systems Nr.2 they have a considerable power and also links with large firms external to the production system that coach them in the creative moments. In production system Nr.3, the small

firms established such strong links that access is guaranteed through resources pooling. In line with Nesse (2000), enterprises can reduce their condition of negative dependency specialising and establishing more and diverse vertical and horizontal links, i.e. making buffers and building bridges. This means, on the one hand, to increase the power and have a better position in the negotiation of productive relationship *vis-à-vis* other companies. On the other hand, to exploit every possibility to learn from the core. This is also the essence of Belussi's approach towards the creation of relational regimes (Belussi, 1999). In order to develop strategies encompassing a reduction of dependency and an increase of power, the firms need to mobilise resources and build heavy network architectures. The reduction of uncertainty and dependency can therefore be achieved maintaining a balance between the resources and competencies internal to the firm and the resources and competencies available in the external environment.

However, the situation of dependency, whether positive or negative does not only "depend" on the factor of access, but also on the second point analysed here, i.e. the willingness of the transferors to share knowledge. This can be observed or measured by looking at the type of linkages existing between the firms. The in-depth analysis of the interdependencies existing within a production system provided the opportunity to investigate the quality of these linkages. As a consequence, it emerged that to acknowledge a situation of dependency is less important than to identify the type of relationship that exists between the dominant and the dependent firm (the core and the rings). Therefore, for the process of learning and its sustainability dependency *per se* is not a negative condition if supported by a learning process that improves the firms' relational position, and the value of production at the same time. Dependency becomes negative when

the relationship reduces the stock and quality of firms' resources (functional downgrading).

In this sense, it is neither the hierarchy within the production systems, nor the market (price), nor trust to determine the conditions for the co-development of the production system. It is rather the willingness of the parties and their interest to share the relevant knowledge. In this perspective, in order to reduce dependency, a firm's option is not only to have more 'exits', as in the traditional views in industrial organisation, but rather to establish shared learning environments with the partners, and hence increase transaction costs. The evidence has shown that for small enterprises the need to co-develop their capabilities is even more stringent. Furthermore, to do it they need a core enterprise actively engaged in the process of learning. Downgrading does not seem to represent a long-term strategy for small firms to survive industrial restructuring. Instead, the creation of a learning framework that is inclusive of as many increasingly specialised and autonomous firms as possible is wished.

The analysis of learning processes cannot be separated the socio-economic, cultural, and institutional context in which the production systems are localised (i.e. the external environment). This relationship has been already highlighted by several authors (see for example Lundvall and Johnson, 1994). The process of creation of interdependencies between firms, networks and industries and its sustainability for the firms involved is also the result of the existing context, and therefore policies aiming at changing the situation should be addressed to the system and not to the firm only. The "structural dynamism" approach to the study of industrial production systems introduced in this study needs to be enriched by including other variables enabling a more encompassing analytical framework for this kind of analysis. This becomes even more important in

the light of the structural changes taking place worldwide in the manufacturing sector.

In the particular case of Denmark, as outlined in chapter three the characteristics of the Danish productive environment have created the conditions for a specialisation and success in the low-technology industries despite the high cost of productive factors. The creation of highly educated workers, a pragmatic approach to social conflicts, the existence of a productive fabric of small enterprises leading to a flexible productive system, and a web of technological institutes, have been central in a situation of lower internationalisation, strong state intervention and low industrial concentration. The situation that characterises the manufacturing sector today -probably this adage can be extended to other sectors as well- needs to review the role of the local institutions and the strength of the informal norms at the base of the village economy. Can the "village economy" survive todays' globalisation of industry? Supported by other studies on small firms in Denmark (cf. Andersen and Christensen, 1998; Christensen, 1999; Christensen and Dalgaard 2000), the analysis of the cases has shown that small firms in particular are subjugated to the strategy of the large companies, which are increasingly internationalised or controlled by foreign capital, and struggling to adapt to the general process of restructuring world-wide. The introduction of foreign capital and interests has created a discontinuity between the local markets and the local interests. Small firms rely increasingly on their ability to establish links with large companies. This is also linked to the problem of replacing the old generation of entrepreneurs. The younger generations are reluctant to take over their father's company because of the uncertainty created by the restructuring process. In this situation the sustainability aspect of learning needs to gain a central position in the analysis.

7. Innovation as strategic reflexivity

An attempt to move in this direction is represented by the strategic reflexivity approach developed by Sundbo and Fuglsang (2002). According to this, innovation stemming from the process of knowledge development through interactive learning is a *reflexive and strategic process* that takes into accounts the needs and demand of all the actors. The cases analysed have shown that the application of the concept of innovation as a *strategic and reflexive* process depends largely on the level of interdependence firms and networks have with other firms and networks. In hierarchical networks, the lead firm imposes the production conditions on the rings. The expectations from the rings are very little and vice versa. In fact, the learning trajectory is influenced by the presence of strong power structures, which reduce expectations about learning as well. In hierarchical production systems, innovative activities are less *strategic* for the small rings and more *reflexive*, trying to satisfy the expectations of the core. Still, if the small firm has a stock of knowledge, representing an important asset, it may influence the de-codification of the knowledge transferred by the core firm and hence be more strategic when introducing an innovation. In less hierarchical systems, the core firm needs to know and integrate as much as possible the knowledge about the other firms' production processes. At the same time, the ring needs to integrate the knowledge about the industry supplied, and provide an adequate response to the core firm expectations' in term of products development. The integration of knowledge is based on a two ways process of learning (as it is in PS Nr.1). The reflexivity of innovation in the small rings may be compared to a process of building up, through interactive learning, intangible assets from

the main block of knowledge supplied by the core firm. Therefore, innovation is 'strategically reflexive' if it enables the ring firm to be an active part of the interacting network in which expectations are created and goals are achieved. Innovation in third production system is clearly the case of strategic reflexivity. Both core and rings of this production system specialise and innovate in a direction that is strategic for the whole network. Strategic reflexivity is seen as the ability of the ring to acquire, absorb and personalise the knowledge produced in interaction with the core firm, and to influence the decision of the core company in adapting and modifying the new product to the technology and knowledge available. By the same token, it represents the ability of the core firm to choose the rings and co-evolve and co-develop with them the novel knowledge leading to the creation of specific assets. In this way a reflexive innovation can help the firms to find alternative roles in highly uncertain environments, instead of working as an exclusion process. This newly developed approach to innovation contributes to overcoming the limits of an understanding of the process of innovation based only on the firms' internal learning activities, it enlarges the spectrum of the analysis to the expectations of the other actors involved in the interaction process. Expectactions are increasingly important in the complexity of the current business environment, as pointed out at the very outset of the thesis, and the approach to innovation as strategic and reflexive represents an important framework for analysing innovation in complex systems.

8. Conclusions, limits of the study and implications for future research

The study has shown that learning is central to the determination of the position of a firm in the production system. In turn, the position in the network architecture has consequences for the individual firm' value creating activities, and for the general growth dynamic of the production system. Learning processes are not activated immediately by interaction between agents. They depend indeed on the willingness of the parties to exchange relevant knowledge, i.e. on the type of relationship established among the different members of the productive network, and on the possibility to access to the relevant knowledge, i.e. the absorptive capacity and resources capability. Willingness and access are in turn, a consequence of the power structures that characterise each network of producers, and which are responsible for what has been defined as the 'governance of the production system'. However, power structures are not defined *a priori*, but are instead defined by the quality of the stocks of resources.

From a conceptual point of view, this has very important implications. Lorenzoni and Lipparini (1999) emphasised that if the learning works, "the lead firms abandon the lead position and add the relational dimension to the efficiency-based consideration traditionally driven by make or buy alternatives".[118] For this, knowledge has been identified as the main resource responsible for the firms' specific assets. And in particular, the internal tacit knowledge embedded in each firm is the fundamental factor in selecting and mobilising the capabilities available in the external environment. For small firms, this perspective is even more central due to the structural limits they have in acquiring codified knowledge. The study

[118] Lipparini and Lorenzoni, 1999, p. 331.

has thus demonstrated that is not the size that determines the position of a firm in the network but its stock of resources and their quality, which are not easy to quantify. This also explains the good innovative performance of firms in low-tech industries, though the concept of innovation has to be reconsidered and include for example design innovation.

The focus on innovative activities and inter-firms cooperation has also shown the importance of the position in the different market segments. The restructuring of the economy is currently posing a dramatic challenge to the firms that are not able to specialise in the high value segments (or that are forced to downgrade). This means that either they have chosen the wrong specialisation trajectory, or remained locked-in the old routines, or basically the production system was not able to induce a co-development process diffused to all the networks' participants. The distributive effects of innovation are an indication of the sustainability of certain changes that can occur within or outside the network.

The "structural dynamism" approach developed in the thesis has re-introduced the role of governance and power structure in the discussion of industrial dynamics. Furthermore, it has shown that in analysing systems of enterprises the dimension to take into account is not the territorial one *sic et simpliciter*. Proximity matters in some kind of learning processes because it facilitates interactions. However, not necessarily knowledge development takes place and then is shared among geographically close firms. More important is that the focus on proximity has distorted the attention from the effects of innovation on the other actors present in the territory. The large amount of concrete case study showing the "beauty" of the "Sunshine Valleys" model of industrial development confirms an attitude towards research made having in mind a specific *ideal type* of production systems, whose end is high levels of *creative destruction* which is believed to foster

economic growth. I have instead in mind another way of making research in which one should distinguish among the various type of *ideal type* a lá Weber, choose one and then carry-out research to see if the concrete cases get closer to that. In line with this thinking, it can be concluded that the preference for some forms of governance characterised by redistributive and inclusive learning dynamics is made by defining *a priori* the ends that can and should be achieved through innovation, and not considering innovation as the end of the process. The study has then demonstrated that the need to consider innovation and learning as sustainable processes leading to a co-development of firms and networks capabilities, and hence conducive to a "shared common environments", emerged as an increasingly important factor in re-addressing the challenges posed by global restructuring.

Finally, this approach, though not exhaustive, has also attempted to mark a path in the conceptual jungle that surrounds the study of international restructuring. In particular trying to link the different elements of analysis, micro, meso, macro, with the different research objects and interests in an interdisciplinary way. The result is a dynamic approach to industrial structures with important grounds of discussion on the policy level in the field of education, technology, innovation and industrial development. Taking into account that there is a wide range of variations in advanced industrial countries, any generalised prescription towards innovation is likely to be unsuitable for the needs of many sectors of the economy and society. This means that, for example, the small economy squeeze can be overtaken with the development of highly dynamic production systems (regardless of their technological sector and the size of the firms involved as demonstrated in the Italian case) with highly

redistributive effects on the territory in terms of knowledge spillovers.[119] However, it is necessary to understand what kind of dynamism takes place in the networks. The danger of a general downgrading of industrial production can be avoided creating strong interdependencies based on co-development and sustainable learning. Linking the different firms in shared common environments will enable the generation of new knowledge and specialised assets, which redistribution among economic actors will avoid the downgrading of production activities and improve the capacity to resist from the shocks caused by the globalisation of production. For these reasons, it has been important to resort to the distinction between autonomous and systemic innovation. Still, a change, whether stemming from a systemic innovation or a restructuring process, needs to be sustainable for the firms in the production system. A change is sustainable if can be firstly appropriated by other network members; and secondly, if it does not put at stake the existence of other firms. Not necessarily and not always, an innovation can be beneficial to all the network members. Adapting and reacting to the new conditions implies that the individual firm is able to learn about the change before the process is too far-gone. This is possible only if the process of learning taking place within the production system enables all the actors to adapt to the new conditions without leaving any firm behind. This consideration roams against the creative destruction which is basic to Schumpeter's understanding of capitalism. Instead, it argues for the need of a more regulated and redistributed process of innovation, which is both strategic and reflexive.

Identifying the innovation trajectories of the small low-tech firms in the production system helped to identify the bottlenecks in the process of

[119] Cf. Becattini, 1998; Bagella and Bechetti, 2000.

innovation and in the distribution of its benefits across the production system. Although the evolutionary perspective embedded in the knowledge-based and resource-based views suggests an economic process radically different from that of equilibration in orthodox theory, a mere evolutionary approach in which the fittest survive ignores the way in which a production system organises and creates its own set of relationships (environment), which are subject to a change under the impact of an innovation in the organisation or in the technology. The interactions between the social and political framework and the changing balance of power within and between production systems suggest a perspective that differs from the theory of the firm, in the sense that this tends to overlook the origin of the firm (Spender, 1996), and that take a distance from the deterministic solution offered by some line of thinking existing within the evolutionary approaches. The structural dynamism approach developed in the thesis reflects instead the complexity of these processes. It is based on the interaction between different levels, firm - production system - markets, and therefore it implies that firms are not distant from the equilibrium but are in a constant state of non-equilibrium in which changes not necessarily need to displace a system with another. Lundvall, Johnson, Andersen and Dalum head towards similar conclusions when they claim that: "interactive learning and innovation immediately sound like a purely positive sum game, in which everybody gains. [...] Increasing rates of learning and innovation may lead not only to increasing productivity and income but also to increasing polarisation in terms of incomes and unemployment".[120]

The study suffers from many limits as well. For example, the difficulty in quantify the indicators have limited the application of the

[120] Lundvall, Johnson, Andersen, 2002, p. 226.

"structural dynamism" approach. The study has identified the main variables but has not achieved to formalise mathematically the model. This kind of problem has been pointed out by Krugman when he is claiming that the externalities from networks are "invisible" since are not quantifyable. Also, from a methodological point of view, the inclusion of other variables that take into account the social context in which the firms of the production systems are embedded would have helped to sort out an attitude that sees firms as purely economic units. Due to the importance of some innovation introduced in the packaging materials, the study could have also benefitted from the inclusion in the sample of the small firms' suppliers of raw materials. However, as stressed in the methodological section of the thesis, it was necessary to put a border to the production system before starting the analysis of its internal dynamics.

Clearly, there is more considerable work to be done before a theory of production system including the "structural dynamism" of its firms can be claimed. The thesis has to be read as a first attempt to demonstrate that the complexity of the learning and innovation dynamics require integrating the existing analysis with more comprehensive methodological tools. Research needs to be done in this direction, enlarging the spectrum of the analysis not only to the internal dynamics of a production system but also to its interconnections with the other sectors of the economy. The low-technology/high-technology divide is not as central as it was believed before. Instead, the strategic dimension of the stock of skills present in each firm is the issue that needs to be analysed in future research as well as the effects of skills development on the communities in which firms are localised.

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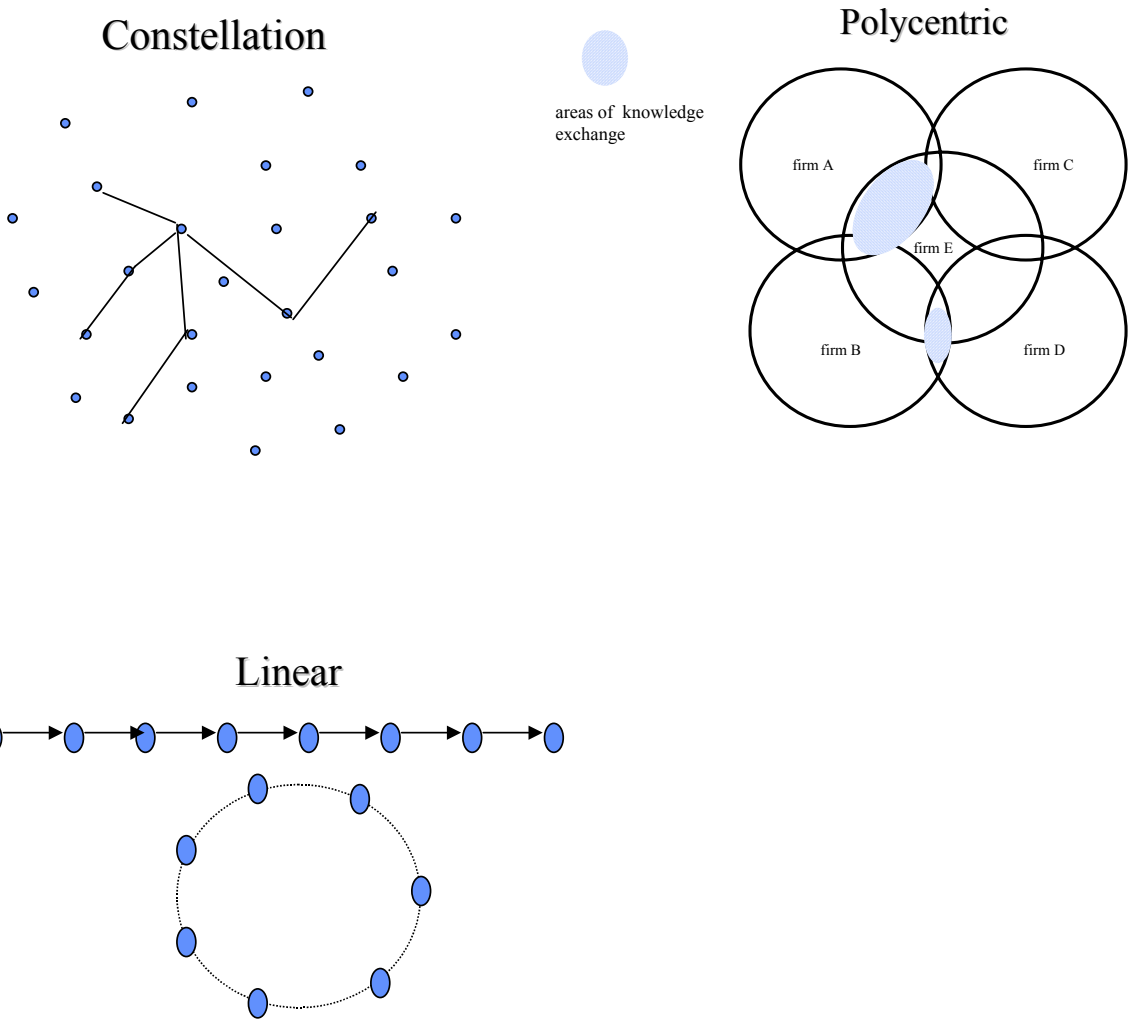
http://industryclick.com

Industrial Statistics on Denmark are available at:

http://di.dk/english

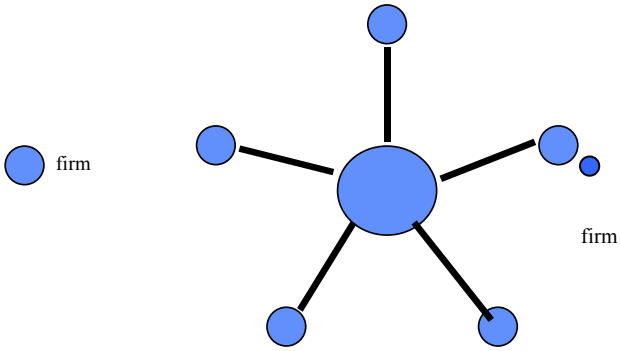
Appendix I - Networks' graphic representations

A-cephalic Networks

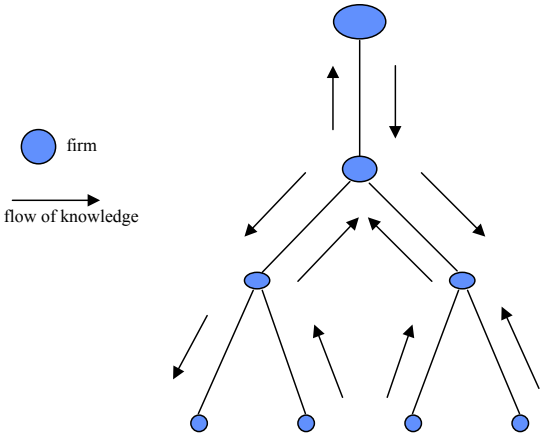


Hierarchical Networks

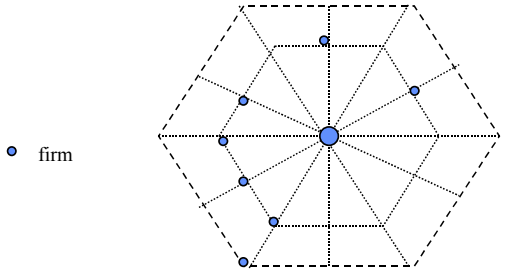
Hub and Spokes



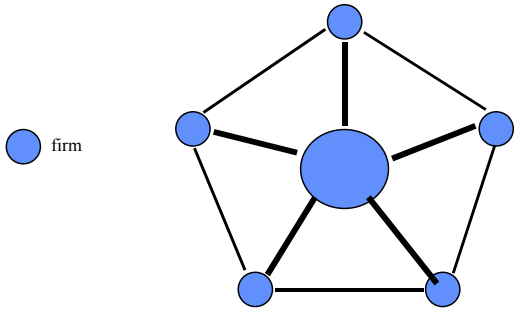
Branch



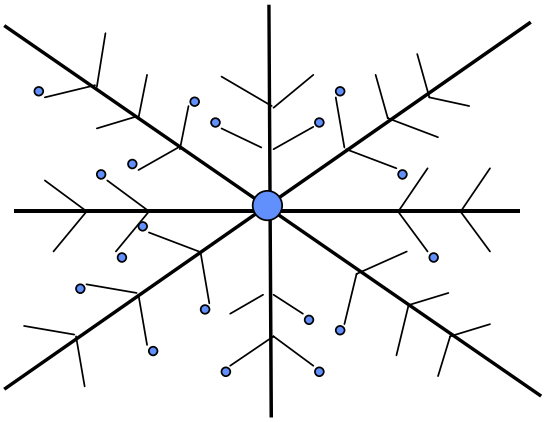
Web



Suppliers Association



Snow Flake



Resume

Objectives and Rationale of the study

This study aims to contribute to the academic debate on the internationalisation of the economy and technology, looking in particular on the effects of the restructuring process of industrial production activities on the small enterprises. The rationale for the study is the emergence of complex networks of production and the creation of different markets within the same geographical space. Long-distance networks crossing national borders and economies, together with the re-discovery of very dynamic molecular forms of capitalism, territorially defined and oriented towards small enterprises, has made the process of innovation, its sources (and hence the sources of advantages of regions and firms) increasingly difficult to detect. Having this in mind the thesis has attempted to answer the question what are the sources of advantage for the small firms and what role small firms are going to play in the current transformation of industrial production.

The thesis attempts to contribute to this intellectual debate by focusing particularly on small firms in low technology sectors. The choice to focus on the low technology sectors of the economy was due to two main aspects: firstly, the fact that small and medium-sized enterprises in the low-tech sectors represent a major share of the industrial firms in Denmark and in the European Union, and hence they are an important stronghold for national economies and employment; secondly, the closeness of low-wages countries, the Baltic countries and Poland in particular, puts Denmark in a vulnerable position in relation to the localisation processes.

The novelty of this thesis lies in the introduction of a systemic analysis of the interrelations between forms of governance, learning processes and markets' dynamics. This approach enabled me to raise other theoretical and empirical questions regarding especially the sustainability of the learning and innovation processes in the firm, as well as innovation as a strategic and reflexive process. The introduction of the concept of sustainability of learning is concerned with the fact that policies and strategies which do not take into account the effects that each innovation has on the system as a whole will not be able to prevent the erosion of the knowledge base of the national economy. This failure is due to the continuous disappearance of weaker and smaller firms from the scene. In this regard, the distinction between radical and incremental innovation is central to the thesis. Instead, the introduction of the strategic reflexivity approach to innovation in the studies on networks, clusters or national production systems, is concerned with the more general problem of the dynamic of appropriation and diffusion of technology and knowledge within complex systems of firms.

The outline of the thesis

The thesis is divided into six chapters. Chapter 1 introduces the research field, the research problems and the methodology applied. In chapter 2, the conceptual framework for analysing power structures' influence on learning and innovation in industrial production systems is outlined. This chapter will attempt to develop a 'language' and a 'syntax' that will enable to carry out the analysis. Chapter 3 looks at the Danish industrial structure and the dynamic of the industries of the firms in the selected production systems from the perspective of the restructuring process. This represents the macro level of the thesis that will enable to put the study of the dynamic of firms and networks in a more general context. Chapter 4 presents the general characteristics of the production systems selected for the analysis, dis-aggregating them at the level of the single units (i.e. firms or network's nodes) and presenting the firms' histories

and activities. It is a descriptive chapter aiming to provide detailed information about the activities, history and specialisation of the firms in the production systems. In chapter 5 the effects of a modification in the governance structure on the small firms are analysed. This will aim to identify the existing power structures, their influence on the creation of new knowledge in the individual firm, and the influence of new knowledge on the power structures. In this chapter the process of creation of networks' capabilities from the single firm capabilities, their upgrading and downgrading, is analysed, trying to highlight the importance of the redistribution of the benefits stemming from innovative activities. In the conclusive chapter, the academic debate concerning the resources of the firm, the process of learning and the economics of networks is revisited and discussed in the light of the "structural dynamism approach". This represented the base for the development of an approach to network and learning that enables to link the dynamic at the level of the firms with that at the level of the production systems and of the markets.

The theoretical framework of the analysis

The research has been carried-out by looking at the two contrasting but parallel views of the lean firm and the relational firm. The lean firm approach by Bennett Harrison and in particular its notion of "concentration without centralisation"[121] has been used to identify the role and creation of the power structures internal to the production system on the small firms. The other view complementary to that of "concentration without centralisation" is the perspective on the "relational firm" emerged in recent years (Belussi *et al.*, 1998; Garud 1994; Afuah, 2000, Gulati, 1998, Gulati and Singh, 1998). This approach is based on the fact that firms are increasingly interested in searching the needed complementary competencies outside their boundaries instead of developing them in-house. In fact, firms are paying greater attention to the establishment of strategic alliances and collaborations with other firms, building up heavy "network architecture". According to this view, the ability of the firm to remain in the high value markets depends on its ability to create strategic interdependencies with other firms in the same market (Garud, 1994; Normann and Ramirez, 1994). This process should induce a process of learning that will be able to mitigate the costs of the general restructuring of the industrial sector. To this another approach was added, developing the notion of "structural dynamism" of production systems. The advantage of this approach is that it may be applied to the analysis of any type of production system, eliminating the influence of factors such as geographical proximity or firms' size, that have received too much attention in the studies on industrial dynamics and local development. Following this approach, the thesis has looked at the crucial research issues of how networks' structural dynamism affects the single firms and how the single firm's internal resources development affects the networks' dynamic, in a given market (which in turn has its own dynamic independent from the others). This view places the role of knowledge development and learning at the centre of the process of reinforcing the firm's relational position within the network. It looks at both the way the change in the power structures affects the learning capability of the firm (and its innovative capacity), and the way the development of new competencies affects the power structures. The advantage of the structural dynamism approach compared to the "relational firm" and the "concentration without centralisation" lies in the ability to connect the different elements (learning, governance and markets) that are responsible of the process of innovation. In this way, the variables at hand are three, of which one (the market) is the independent one. In fact, if the "relational firm" approach can explain the creation of the governance and the "concentration without centralisation" the dynamic of the process of learning in different type of hierarchies, only with the inclusion of the markets' dynamic how the structures and the processes change can be explained.

[121] Harrison, 1994.

Empirical results and main conclusions from the case study

Although in qualitative research on inter-firms relationship longitudinal studies are preferred, the study at hand provides enough stylised facts to draw implications for current research on industrial dynamic. In synthesis, from the study has emerged that:

- The dynamic of the single firm needs to be studied from a systemic perspective;
- The "structural dynamism" of the systems, i.e. the intertwining of the resources dynamic and the governance structures in given markets determines the performance of the firms involved;
- Innovation in small low technology firms is subject to the quality of the relationship established with the other firms of the network;
- Intangibles are increasingly strategic for small firms in the low-tech sectors, although in some industries (such as in the folded carton packaging) productive capacity is increasingly decisive;
- Highly hierarchical networks are less incline to redistribute the benefits from the learning processes in terms of knowledge sharing;
- Lack of knowledge sharing among networks' members can lead to the exclusion of some firms from the network;
- This in turn produces an erosion of the networks' knowledge base and the creation of dual markets within the same productive sector;
- The dependency between firms in the same network, regardless of the internal level of hierarchy, is not necessarily negative. Firms can still learn despite a high dependency from the core;
- Collective learning is limited, despite the "cultural" heritage shared by the firms. Only in few cases "shared common environments" are created;
- Large firms are increasingly flexible and the risk associated to stock- keeping and payment delays are transferred to the small firms, which in this way finance the large firms;
- Innovation in small firms is an increasingly reflexive process that takes into account the expectations of the partner but is less strategic since it depends increasingly on the power structure;
- Opposite, for large firms innovation is more strategic than reflexive, since they take less into account the needs of the small firms.

The thesis has also shown that there is not an epochal shift from large enterprises to small enterprises. Instead, as pointed out by Belussi (1999), there is a "possible co-evolution of differentiated structures", together with a process of "economic re-centralisation" due to the necessity to have a minimum organisational threshold and to the reduction of coordination costs with the introduction of information and communication technologies.[122] In this new complex production regime new interdependencies are continuously created and are subject to continuous change. The study of the single cases has highlighted that market fluctuations and the strategy of large firms induce a process of inclusion and exclusion. The result is a dual structure within similar industries. This will probably always occur in a capitalist system, but the most important aspect is to understand how inclusiveness can be stimulated. The explanation was based on the assumption that the firms that remain in the network have the opportunity to upgrade their capabilities, while those that are excluded are relegated to a secondary market. Gaining a position in a high value markets gives a certain prestige and regularity of orders. While the lack of integration in the network produces negative dependency, imposition of tight delivery conditions and timing, and eventually downgrading of functions,

[122] Belussi, 1999, p. 731 and p. 733.

which in the long run means a reduction of value added and erosion of knowledge. The problem investigated in the research lies in the identification of these dynamics and their effects on the small firms.

Conclusions, limits of the study and implications for future research

The study has shown that learning is central to the determination of the position of a firm in the production system. In turn, the position in the network architecture has consequences for the individual firm' value creating activities, and for the general growth dynamic of the production system. Learning processes are not activated immediately by interaction between agents. They depend indeed on the willingness of the parties to exchange relevant knowledge, i.e. on the type of relationship established among the different members of the productive network, and on the possibility to access to the relevant knowledge, i.e. the absorptive capacity and resources capability. Willingness and access are in turn, a consequence of the power structures that characterise each network of producers, and which are responsible for what has been defined as the 'governance of the production system'. However, power structures are not defined *a priori*, but are instead defined by the quality of the stocks of resources.

From a conceptual point of view, this has very important implications. Lorenzoni and Lipparini (1999) emphasised that if the learning works, "the lead firms abandon the lead position and add the relational dimension to the efficiency-based consideration traditionally driven by make or buy alternatives".[123] For this, knowledge has been identified as the main resource responsible for the firms' specific assets. And in particular, the internal tacit knowledge embedded in each firm is the fundamental factor in selecting and mobilising the capabilities available in the external environment. For small firms, this perspective is even more central due to the structural limits they have in acquiring codified knowledge. The study has thus demonstrated that is not the size that determines the position of a firm in the network but its stock of resources and their quality, which are not easy to quantify. This also explains the good innovative performance of firms in low-tech industries, though the concept of innovation has to be reconsidered and include for example design innovation.

The focus on innovative activities and inter-firms cooperation has also shown the importance of the position in the different market segments. The restructuring of the economy is currently posing a dramatic challenge to the firms that are not able to specialise in the high value segments (or that are forced to downgrade). This means that either they have chosen the wrong specialisation trajectory, or remained locked-in the old routines, or basically the production system was not able to induce a co-development process diffused to all the networks' participants. The distributive effects of innovation are an indication of the sustainability of certain changes that can occur within or outside the network.

The "structural dynamism" approach developed in the thesis has introduced the role of governance and power structure in the discussion of industrial dynamics. Furthermore, it has shown that in analysing systems of enterprises the dimension to take into account is not the territorial one *sic et simpliciter*. Proximity matters in some kind of learning processes because it facilitates interactions. However, not necessarily knowledge development takes place and then is shared among geographically close firms. Ore important is that the focus on proximity neglects the effects of innovation on the other actors present in the territory. The large amount of concrete case study showing the "beauty" of the "Sunshine Valleys" model of industrial development confirms an attitude towards research made having in mind a specific *ideal type* of production systems, whose end is high levels of *creative destruction*. I have instead in mind

[123] Lipparini and Lorenzoni, 1999, p. 331.

another way of making research in which one should distinguish among the various type of *ideal type* a lá Weber, choose one and then carry-out research to see if the concrete cases get closer to that. In line with this thinking, it can be concluded that the preference for some forms of governance characterised by redistributive and inclusive learning dynamics is made by defining *a priori* the ends that can and should be achieved through innovation, and not considering innovation as the end of the process. The study has then demonstrated that the need to consider innovation and learning as sustainable processes leading to a co-development of firms and networks capabilities, and hence conducive to a "shared common environments", emerged as an increasingly important factor in re-addressing the challenges posed by global restructuring.

Finally, this approach, though not exhaustive, has also attempted to mark a path in the conceptual jungle that surrounds the study of international restructuring. In particular trying to link the different elements of analysis, micro, meso, macro, with the different research objects and interests in an interdisciplinary way. The result is a dynamic approach to industrial structures with important grounds of discussion on the policy level in the field of education, technology, innovation and industrial development. Taking into account that there is a wide range of variations in advanced industrial countries, any generalised prescription towards innovation is likely to be unsuitable for the needs of many sectors of the economy and society. This means that, for example, the small economy squeeze can be overtaken with the development of highly dynamic production systems (regardless of their technological sector and the size of the firms involved as demonstrated in the Italian case) with highly redistributive effects on the territory in terms of knowledge spillovers.[124] However, it is necessary to understand what kind of dynamism takes place in the networks. The danger of a general downgrading of industrial production can be avoided creating strong interdependencies based on co-development and sustainable learning. Linking the different firms in shared common environments will enable the generation of new knowledge and specialised assets, which redistribution among economic actors will avoid the downgrading of production activities and improve the capacity to resist from the shocks caused by the globalisation of production. For these reasons, it has been important to resort to the distinction between autonomous and systemic innovation. Still, a change, whether stemming from a systemic innovation or a restructuring process, needs to be sustainable for the firms in the production system. A change is sustainable if can be firstly appropriated by other network members; and secondly, if it does not put at stake the existence of other firms. Not necessarily and not always, an innovation can be beneficial to all the network members. Adapting and reacting to the new conditions implies that the individual firm is able to learn about the change before the process is too far-gone. This is possible only if the process of learning taking place within the production system enables all the actors to adapt to the new conditions without leaving any firm behind. This consideration roams against the creative destruction which is basic to Schumpeter's understanding of capitalism. Instead, it argues for the need of a more regulated and redistributed process of innovation, which is both strategic and reflexive.

Identifying the innovation trajectories of the small low-tech firms in the production system helped to identify the bottlenecks in the process of innovation and in the distribution of its benefits across the production system. Although the evolutionary perspective embedded in the knowledge-based and resource-based views suggests an economic process radically different from that of equilibration in orthodox theory, a mere evolutionary approach in which the fittest survive ignores the way in which a production system organises and creates its own set of relationships (environment), which are subject to a change under the impact of an innovation in the organisation or in the technology. The interactions between the social and political

[124] Cf. Becattini, 1998; Bagella and Bechetti, 2000; Farinelli, 1996.

framework and the changing balance of power within and between production systems suggest a perspective that differs from the theory of the firm, in the sense that this tends to overlook the origin of the firm (Spender, 1996), and that take a distance from the deterministic solution offered by some line of thinking existing within the evolutionary approaches. The structural dynamism approach developed in the thesis reflects instead the complexity of these processes. It is based on the interaction between different levels, firm - production system - markets, and therefore it implies that firms are not distant from the equilibrium but are in a constant state of non-equilibrium in which changes not necessarily need to displace a system with another. Lundvall, Johnson, Andersen and Dalum head towards similar conclusions when they claim that: "interactive learning and innovation immediately sound like a purely positive sum game, in which everybody gains. [...] Increasing rates of learning and innovation may lead not only to increasing productivity and income but also to increasing polarisation in terms of incomes and unemployment".[125]

The study suffers from many limits as well. For example, the difficulty in quantify the indicators have limited the application of the "structural dynamism" approach. The study has identified the main variables but has not achieved to formalise mathematically the model. This kind of problem has been pointed out by Krugman when he is claiming that the externalities from networks are "invisible" since are not quantifyable. Also, from a methodological point of view, the inclusion of other variables that take into account the social context in which the firms of the production systems are embedded would have helped to sort out an attitude that sees firms as purely economic units. Due to the importance of some innovation introduced in the packaging materials, the study could have also benefitted from the inclusion in the sample of the small firms' suppliers of raw materials. However, as stressed in the methodological section of the thesis, it was necessary to put a border to the production system before starting the analysis of its internal dynamics.

Clearly, there is more considerable work to be done before a theory of production system including the "structural dynamism" of its firms can be claimed. The thesis has to be read as a first attempt to demonstrate that the complexity of the learning and innovation dynamics requires integrating the existing analysis with more comprehensive methodological tools. Research needs to be done in this direction, enlarging the spectrum of the analysis not only to the internal dynamics of a production system but also to its interconnections with the other sectors of the economy. The low-technology/high-technology divide is not as central as it was believed before. Instead, the strategic dimension of the stock of skills present in each firm is the issue that needs to be analysed in future research as well as the effects of skills development on the communities in which firms are localised.

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[125] Lundvall, Johnson, Andersen, 2002, p. 226.