Pontus Braunerhjelm

Knowledge Capital, Firm Performance and Network Production

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The issues I address in this thesis concern the role of SMEs in perspective of the technological change that has occurred in the last decades, and the increased internationalization of economic activities. Traditional ways of organizing industrial production have undergone dramatic and rapid changes during the last decades. Vertically integrated firms and Tayloristic structures have increasingly been replaced by organizations characterized by networks, clusters, and other informal cooperation between economic agents founded on mutual trust and interdependence. Such reorganization of industrial production opens up new opportunities for small and medium sized firms, but also put these firms' abilities to respond to the new challenges to a severe test. In particular, the internationalization of production that emanates from the dismantling of trade and investment barriers, in addition to advances in information technology, will stiffen the competition on previously sheltered markets. Differences in prices and qualities will become more transparent, and the prospects for firms that fail to cope with these new conditions and requirements are bleak. Hence, a continuous upgrading of the firms' knowledge capital in terms of R&D capacity, marketing knowledge, and a skilled work force will become crucial ingredients for firms to remain competitive, irrespective of size.

Most of the thesis work has been undertaken at the IUI (The Research Institute of Industrial Economics) in Stockholm. IUI has a long tradition in this field, originating in Professor Erik Dahmén's seminal contributions to industrial organization and industrial dynamics in the early 1950s. Special thanks to IUI colleagues for commenting on earlier version of this manuscript, particularly Erik Mellander and Roger Svensson. Roger Svensson has been my co-author in chapter 6, which assures that it contains a sophisticated empirical analysis. I am also grateful to Professors Magnus Blomström, Bo Carlsson and Gunnar Eliasson for commenting on different parts of the thesis. Moreover, Chapter 5 contains part of the joint work that I and Bo Carlsson have been undertaken in recent years. Three of the chapters, which have been accepted for publication in international journals, have also benefited from comments by anonymous referees. I also like to express my gratitude to my thesis advisor, Professor Börje Johansson, for his knowledgeable comments, which substantially improved the contents of the thesis.

Finally, Per Thulin has provided excellent assistance with part of the empirical work, while Elisabeth Gustafsson helped to turn the different chapters into a coherent manuscript. For part of the work, generous financial support has been provided by the Marianne and Marcus Wallenberg Foundation and The Swedish National Board for Industrial and Technical Development (NUTEK).

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CHAPTER 1

1. Introduction

1.1 Background

The organization of industrial production has undergone considerable changes during the last couples of decades. In particular, decentralization, or downsizing, and internationalization have been two conspicuous features of the organization of industrial activity. These trends, partly originating in the dismantling of trade and capital barriers, seem to interact and reinforce each other as competition is sharpened between firms. This development also carries important repercussions as regards the operations of small and medium sized firms (SMEs). This thesis will focus on the implications of these changes for SMEs.

One particular aspect of decentralization is that production tends to be increasingly organized in complex networks, cluster and technological systems, opening up new opportunities from SMEs. Such networks can comprise an impressive number of firms and also stretch over several countries, or even continents. But they may also induce agglomeration into narrow geographically concentrated areas. The replacement of traditional vertical organizations for network structures allows firms to increase their degree of specialization, and the development is largely propelled by the increased international competition. It has forced firms to adopt the most efficient ways of organizing production, and to implement technologies that minimize slacks and enable firms to fulfil the requirements of individual customers. Cooperation through networks, aiming at integrating complementary competencies and to intensify transmission of knowledge between networks participants, is hence one strategy firms have chosen to come to grips with this novel situation. A factor of importance in this evolution is of course the rapid advance in information technology and the improved possibilities it brings with it in terms of monitoring and coordinating geographically dispersed activities.

That brings us to the second major trend in industrial organization, i.e.

internationalization, where the deregulation of barriers to trade and capital flows between different markets led to unprecedented global levels of foreign direct investments during the 1980s, paired with expanding trade. As a consequence, firms began to take locational issues into more serious consideration. Although such preponderance would seem to primarily affect large firms, they would of course also indirectly affect SMEs. First, a shift in location may imply changed supplier links, comprising elements of internationalization as well as levying new demands on former suppliers. Second, it means that SMEs, operating on previously sheltered markets, will to a larger extent be exposed to international competition. In fact, the quest for change will be particularly obvious for the SMEs since large firms often have a superior experience of operating in international environments characterized by fierce competition. This gives rise to a number of question with regard to the SMEs. Do they possess the specific knowledge required to meet such changed prerequisites in industrial production? Can knowledge variables be shown to have a positive effect on firm performance in terms of profitability and international competitiveness? Is there any reliable way of measuring network activities? Is the location of large firms determined by the prevalence of an existing stock of SMEs, indicating that a support structure in terms of suppliers and adequate labor skills are present? Are such existing support systems more important in knowledge-intensive industries? The answers have important policy implications, not least for growth as has been pointed out in the endogenous growth literature. The possibilities for sustainable long-run growth and welfare to large extent hinge on countries' industrial dynamics and flexibility, i.e., the capacity of individuals and firms to engage in knowledge enhancing and value-adding activities.

1.2 Industrial organization and the role of SMEs

Already in the late 19th century the conclusion was forwarded that SMEs would gradually become marginalized in economic operations. For a long time this prophecy also seemed to materialize as scale gained in importance up to the late 1960s (Sengenberg, Loveman and Piore, 1990). Around that time, however, an increase in the share of employment allotted to SMEs started to show up in most industrialized countries, despite differences in initial conditions, culture and the institutional framework. Although skepticism concerning the importance of SMEs have been expressed (Davis, Haltiwanger and Schuh, 1993; Brown, Hamilton and Medoff, 1990), there seem to be little doubt that a shift took place in the late 1960s, beginning of the 1970s (see for instance Carlsson, 1989; Acs and Audretsch, 1990, 1994; Commission of the European Communities 1990, 1992, 1994; Gallagher and Robson, 1994).[1]

Among the first studies to recognize the increased importance of SMEs was Birch's analysis on job creation emanating from smaller firms. He purported that the overwhelming part of new jobs was supplied by new and small firms. Also Birch has received criticism for his findings. Sengenberger et al (1991), for instance, claimed that Birch confused firms with establishment and that a large part of the new jobs attributed to small firms indeed was due to the reorganization and downsizing of large firms. Yet, later studies, for example the OECD reports of 1985 and 1992, as well as recent Swedish analyses (Davidsson, Olofsson and Lindmark, 1994, 1996), reach the same conclusion as in Birch's original study.

Industrial dynamics and innovations is another field where SMEs have experienced a reassessment lately (Kamien and Schwartz, 1975; Rothwell and Zegweld, 1982; Doctor, van der Haorst and Stokman, 1989; Carlsson and Braunerhjelm, 1994; Davidsson, Olofsson and Lindmark, 1994; Audretsch, 1995; Cohen and Klepper, 1996). Audretsch (1995) argues that even though the traditional knowledge production function, linking knowledge input (R&D) to innovative output, may be valid, it does not necessarily imply that large firms in isolation are the prime sources of such output. Doubtlessly they are the main producers of knowledge in terms of R&D, yet the environment in which firms operate may constitute the critical factor in separating failures from success. Spillovers from a large numbers of firms as well as other agents (universities, research institutes, etc.) consequently have a complementary effect on other firms performance and R&D investments (Feldman, 1994; Saxenian, 1994). That may also be the explanation to the important innovative activities undertaken by a large number of small firms (Link and Rees, 1990).The transmission of knowledge is generally disregarded in macro-oriented models of growth although it seem inevitable that small firms and individuals are crucial in this process (von Hippel, 1987; Carlsson and Braunerhjelm, 1994; Acs, Audretsch and Feldman, 1992; Acs, Audretsch and

[1] For a criticism of Davis et al (1993) criticism, see Davidsson (1995).

Feldman, 1994; Audretsch and Feldman, 1995). Linked to this is the institutional setup in an economy which provides the rules of the game, not least the possibilities of collecting information, communicating and experimenting, when organizing knowledge enhancing activities (Davis and Henrekson, 1996; Eliasson, 1991, 1996; Henrekson, 1996; Henrekson and Johansson, 1998).

The recognition of the mechanisms of transmission of knowledge is closely linked to the modifications in organizing industrial production that recently has emerged. In addition, the move towards more decentralized and flatter organization, while at the same time core competencies are emphasized, in many ways gives SMEs a new and extended role.[2] As the organization of industrial production has shifted towards networks, and technological systems, a higher degree of specialization of the participants is made possible where scale is gained on a higher level than the individual firm. For instance, several participants may in various ways contribute with knowledge inputs into each firm's production. This allows the operating scale of firms to remain relatively small.

1.3 Purpose, methodology and limitations

The purpose of this thesis threefold: First, to explore the structure of Swedish firms in the manufacturing sector with regard to their degree of internationalization and their knowledge base, distributed on different size classes. Second, to empirically examine the importance of knowledge and size in order for a firm to attain international competitiveness. The composition and determinants of firms' knowledge base will be considered, as will the explanations of firms' internationalization, particularly the role of size. Size is important to exploit economies of scale and minimize per unit fixed costs. However, the costs of installing new production technology has fallen (computerized system, robots) and economies of scale also appear on levels exceeding the firm through different networks and agglomeration economies. Thirdly, we analyze the role of an existing stock of SMEs in attracting location of large firms. One question that will be addressed is whether the importance differs between different industries, i.e.

[2] See for instance Jarillo, 1988; Szarka, 1988; Markusen, 1996. For a Swedish perspective, see Johansson, Karlsson and Westin, 1994.

if agglomeration forces seem to differ across industries. Agglomeration economies, or networks externalities, reduce production costs through externalities originating in different kinds of spillovers.

Although both theoretical and empirical issues are considered in the thesis, emphasis is on the empirical side. In Chapter 2, the problem is introduced by giving a picture of the Swedish SME-sector in an international perspective. In addition, the chapter presents a detailed description of SMEs in the Swedish manufacturing sector, where a comparison is undertaken with regard to specialization, internationalization, and knowledge factors, for different size categories. Part of this data set will be implemented in the empirical analyses in Chapters 3 and 4.

The purpose of Chapters 3 and 4 is on one hand to examine the determinants of firms' knowledge endowments, and on the other hand to investigate the relation between the endowments of such knowledge stocks and firm performance in terms of profitability and international competitiveness. The hypotheses of a positive relationship between the stock of knowledge and firm performance are supported.

In Chapter 5 the aim is to introduce a method how to measure agglomeration, where the two crucial ingredients are interaction among firms and geographical proximity, is presented and implemented on Swedish and U.S. data. Agglomeration is assumed to be a proxy for interaction among firms, containing both demand and supply linkages. A survey on the literature on agglomeration, or clustering, is also presented.

In Chapter 6 the propensity of large firms to locate in areas already abundant in similar production is examined. The purpose is to examine to which extent the presence of cluster act as a centripetal force in attracting investment of firms involved in similar activities. To achieve this end we pool a unique database on Swedish multinational corporations (MNCs) with country data. Tobit and Probit methods are applied to derive the factors that influence location by the large Swedish firms.

The analyses is restricted to the manufacturing sector (with the exception of Chapter 5) which of course is a limitation since most SMEs can be found in the service sector and it also where growth in terms of numbers of firms and employees has been strongest in the last decades. Moreover, service companies have become important parts of the production networks that have evolved in recent years. Still, private services are closely tied to the production of goods. Furthermore, a large part of the empirical analysis is cross-sectional, implying that we cannot say much about the development over time. Thus we largely exclude questions regarding the number of firms over time, entry of new firms, and similarly related dynamic issues. This also means that we cannot separate between different sources that have affected those variables, as externalization of units and downsizing.

1.4 Theoretical background

A key question concerns the capabilities of SMEs that overcome the drawbacks of being small. Already Mill claimed in the mid 19th century that a tendency towards large-scale organization of businesses would lead to the demise of SMEs. This view was pursued - although for different reasons - by Marx and Schumpeter, and in the aftermath of the industrial revolution the share of employment in large units did indeed increase. At present, however, rather the opposite finding prevail.[3]

What factors determine the size distribution of firms?[4] Even though the question may appear somewhat naive it has occupied several economists over the years, particularly since economies of scale in production is a standard assumption in much of economic modeling. Scale economies seem, however, to become increasingly important for activities outside the actual production process. Examples of such activities are R&D, marketing, finance etc. from which several production units within a firm can extract benefits. Hence, a distribution of a large number of small establishment may be compatible with a market dominated by large firms. Alternatively, firms may draw on benefits related to a cluster, e.g., network economies of different kinds.

One reason for the changing size distribution of firms is provided by technological progress. On the one hand, production technology sets the limit for the operating units. As technology improves over time, different vintages apply to different scales. Hence, the distribution of firm size has a time aspect. Furthermore, technological progress

[3] The role of the entrepreneur, and the factors that are conducive for an entrepreneurial environment, will not be addressed in this thesis. For an excellent overview, see Wennekers, Thurik and Buis (1997). See also Davidsson (1989).

[4] As regards the size distribution, or convergence of size distribution, see also Gibrat (1931) and Jovanovic (1982). A survey of the literature can be found in Schmalensee (1989).

paired with considerable reductions in the costs of acquiring new technology has revolutionized SME flexibility (Carlsson, 1984; Johansson, 1991; Carlsson and Taymas, 1992; Eliasson, 1996).[5] On the other hand, information technology also affects the plant size and the organization of production within the firm. It gives access to information at lower costs, and also makes information easier to process and interpret, which weakens the scale argument in production. However, it could also be argued that the establishment of larger firms is facilitated since control and monitoring possibilities increase with improved information technology.

To explain the SME success, a number of sources of diseconomies of scale have been suggested that may offset potential economies of scale. These offsetting factors are, for example, limited supply of strategic factors, decreasing efficiency of factors as scale increases, disproportional increasing costs of management due to coordination and monitoring costs, decreasing motivation and increasing selling and distribution costs. Especially the scarcity of human capital and entrepreneurial skill is regarded as constraints to growth (Lucas, 1979; Brock and Evans, 1986). Other deterrents to growth are also small home country markets and difficulties in raising capital necessary for expansion. Especially the latter factor has been viewed as a major obstacle to growth (Penrose, 1956; Horwitch and Pralahad, 1976; Buckley, 1986).[6]

1.5 Internationalization

To start with, the meaning of internationalization has to be defined. In its general meaning it alludes to a wide range of international penetration and commitment, comprising exports, sales agents, as well as wholly owned production units abroad. Internationalization by SMEs predominantly takes the form of exports, while setting up subsidiaries abroad is less common. Furthermore, export performance by SMEs differs widely between countries. The explanation is related to different size of the home

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[5] See also Sabel (1983) and Piore-Sabel (1984).

[6] Financial constraint is habitually regarded as a severe bottleneck for SMEs. Some studies, however, point in another direction. Lindquist (1991) for instance, in her study on small Swedish high-tech firms, finds little support for financial constraints and similar results are reported for English SMEs (Burns and Dewhurst, 1986). The ongoing integration of financial markets is also favoring SMEs. However, during the transition from regulated to integrated markets it is possible for financial institutions to charge SMEs higher costs by exploiting information differences (Oxelheim 1992).

country markets, the structure of the industry, governmental policies, etc.

A theoretical rationale for internationalization has been provided by Hymer (1961), Buckley and Casson (1976), Williamson (1975, 1985), Caves (1982) and others. In short, the argument is that the lack of markets for firm-specific assets, or knowledge, induce firms to internalize production in wholly owned subsidiaries abroad. Arm's length contracts are not possible since they may erode the firm-specific advantage through different kinds of opportunistic behavior. Therefore firms prefer to expand through Foreign Direct Investment (FDI) rather then through cooperative arrangements as licensing, etc. In fact, this argument can be attributed to Coase's explanation of the rationale of the firm (Coase, 1937). However, firm-specific assets (FSA) are not just given to firms, rather they are acquired through R&D investments, which in turns require scale in production.

A particular branch of the above theory is the behavioristic approach to explain internationalization, which is often regarded as particularly relevant for SMEs (Aharoni, 1966; Johansson and Vahlne, 1977). A sequential process is visualized, where close markets - in terms of geographical and cultural distances - are first exploited. Expansion to other markets then gradually proceeds, both in terms of markets and means of internationalization, i.e. export agents are substituted for sales affiliates, etc., and finally producing subsidiaries are established.

A more novel framework is introduced by Porter (1980, 1990). He conceptualizes factors that generate specific skills and abilities to the firms in the so-called "diamond", which explicitly enumerate six factors that determine the competitiveness of firms of different nations. Since "diamonds" differ between countries, trade and internationalization takes place. Hence, the model has a factor endowment flavor although Porter stresses that favorable production conditions are partly created. He regards this as the main determinant in sustaining competitiveness on the firm level. The interlinks to the industrial network approach are close, where emphasis is on the establishing and developing of networks in the internationalization process (Arthur, Hendry and Jones, 1991; Johansson and Mattson, 1988; Malecki, 1985; Markusen, 1996).

Turning to the issue at focus in this dissertation, i.e., internationalization, knowledge capital, and size, the first attempt to combine these factors into an analytical framework was the eclectic approach (Dunning, 1977), i.e. the OLI-theory, which - rather than providing a full theory - discusses the necessary conditions for foreign production to take place. The OLI-theory is named after the three main factors influencing FDI: ownership advantages, i.e. firm-specific assets are represented by O, while L stands for locational advantages in host countries, and I refers to the internalization of firms' proprietary assets. The lack of markets for firm-specific assets tends to make transaction costs - or the risk of being exposed to "opportunistic behavior" (Williamson, 1975) - excessively high for arm's length contracts and similar arrangements, which induce internalization of production through FDI. Regarding the locational factors, the OLI-theory maintains that in order to attract FDI the recipient country has to offer some particular country-specific advantage. Such advantages are, for instance, sizable markets, access to specific skills, cost of production factors, or policy-designed incentives. These are necessary conditions for FDI, however, they are not sufficient since firms always have the option to substitute FDI for exports from the home country.

A more recent vein in this field of economic theory is the "new" locational literature which focuses on the choice taken by firms with regard to the mode of internationalization (Markusen, 1995; Brainard, 1997; Braunerhjelm and Ekholm, 1998). Depending on the type of economies of scale and the level of trade costs, firms will either export from their home countries or set up a foreign plant in other countries. Related to this are issues concerning agglomeration, i.e. why firms in a specific industry tend to be concentrated in certain geographically well-defined areas, even though costs are higher. The rationale for such agglomeration behavior is traditionally ascribed to the advantages arising from demand and supply linkages or intra-industry technological and information spillovers. In the former case, the possibility to be linked up to networks of suppliers and distributions constitute one reason for concentrate production (Krugman, 1991a, b; Venables 1996).

The size of the firm is given a key role in the choice of internationalization mode. Economies of scale is assumed to either appear on the firm or plant level, alternatively being a mixed of the two. The first type of economies of scale is defined as emanating from knowledge producing activities, for instance R&D operations. Such knowledge can be used as a non-rivalry, blueprint assets in many plants, irrespective of their locations. Economies of scale that arise on the plant level must however be exploited at one particular location and requires that a certain level of production can be attained at that specific location. Together with trade costs, the level and type of scale economies determine the mode of internationalization. Generally, high transportation costs induce FDI even though economies of scale on the plant level may be high, while zero transportation costs tend to make all firms exporters.[7] Hence, size (scale) enters a decisive variable in determining the type and extent of internationalization.

The following general pattern can be derived from these locational models based on the general equilibrium paradigm: whether firms penetrate foreign markets through exports or direct investments, they need to possess some kind of firm-specific assets. Furthermore, the choice between exports and foreign direct investments is partly dictated by the type of economies of scale. More particularly, the larger economies of scale on the plant level, the larger the probability that the firm will pursue an export strategy. The costs of trade will also affect the chosen strategy, however, in the forthcoming we will focus on countries where Sweden has had more or less free trade for a long time and hence we can disregard the trade cost factor.

To summarize, the theories outlined above all stress the importance of developing some firm-specific asset or unique product that leads to competitive capabilities which can be exploited abroad. Different sizes of firms are associated with specific advantages as well as disadvantages. Therefore, it can be expected that firms of different sizes are likely to cooperate and coexist, fulfilling different and complementary tasks, a conclusion forwarded already by Marshall (1890). One indication of such co-existence is that, on average, profit levels of SMEs match large firms quite well and even surpass them in some cases (Aigingen and Tichy, 1984; Burns and Dewhurst, 1986; Braunerhjelm, 1991a, b).[8]

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[7] Another reason for agglomeration can be derived from the new growth theory (Romer, 1986; Sala-i-Martin, 1990; Martin and Ottaviano, 1997). It is argued that knowledge enhancing activities can only partly be appropriated by firms, implying that an externality is created and diffused to other firms, thereby reducing their costs (Griliches, 1979). Also strategic reasons may induce firms to set up foreign affiliates instead of exporting.

[8] One explanation forwarded on the impressive profit performance by SMEs relates to different managerial organizations in SMEs and LEs. The former are claimed to be managed by owners who are more inclined towards maximizing profits then hired management.

1.6 Organization of the thesis

The following Chapter 2 gives a detailed description of the size distribution of Swedish firms and contrast this picture with the distribution in other countries. In addition, a comparison between small firms, medium-sized and large firms with regard to factors judged as being of core importance for their ability to meet a higher degree of competition in the future is undertaken. Emphasis is on their internationalization and knowledge stocks. Part of these data will be implemented in the empirical analyses in the following chapters.

In the two following chapters (Chapter 3 and Chapter 4), the role of knowledge in explaining firm performance, i.e. profitability and international competitiveness, is investigated. The determinants of knowledge assets are examined, albeit from a different perspective and implementing different methods. A knowledge stock variable is introduced that more closely relates to the theoretical concept of firm-specific assets. In addition to investments in R&D, it also takes into account the accumulation of assets in marketing, education and software. The theoretical rationale for firms to embark on internationalization strategies, rather than get involved in arm's length contracts, is attributed to the internalization of firm-specific assets. The analysis generates the following main results: First, it is shown how firms' endowment of knowledge is related to their skill structure of their employees, and the size of the firm. However, as captured by the quadratic size variable, the impact of size is diminishing. It can interpreted as if beyond a certain threshold, a further increase in size adds little to the knowledge endowment within the firm, indicating that the firm can not efficiently handle a too large endowment of knowledge. Second, we also find that large knowledge stocks act as a shift factor on firm profitability while the influence of size, or market power, was negligible. Furthermore, size, together with firms' knowledge stocks, constitute the main explanations of the degree of internationalization. Finally, different modes of internationalization seem to substitute for each other.

The next two chapters are involved with issues related to agglomeration, clusters and networks. In Chapter 5 a method for identifying clusters, based on interaction across industries and geographic proximity, is presented. In the following chapter (Chapter 6), unique data on Swedish multinationals is combined with industry data for

18 countries, the influence of host country characteristics on the location of foreign production is analyzed. Particular attention is directed towards agglomeration tendencies in firms' location. Since in most countries the major part of firms are small, we argue that the prevalence of a large production sector can be used as a proxy for a large number of SMEs in that industry. If Swedish firms predominantly invest in countries already abundant in similar production, we interpret that as if the existence of a relatively large number of SMEs constitutes an attractive factor as large firms determine where to locate production. The results suggest that agglomeration effects are present, predominantly in technologically advanced industries. It is also verified that market size, the supply of skilled labor and earlier exports pattern, affect the location of overseas production.

In the concluding Chapter 7, the main findings are summarized. The policy implications suggested thereby are discussed, as is avenues for future research in this area.

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CHAPTER 2

2. The Swedish SME-sector in an international perspective

2.1 Introduction

A significant characteristic of industrial organization in the postwar era, at least up to the 1980s, is the establishment of large international firms, designed for mass-production of standardized goods. For a number of reasons, traditional wisdom has regarded production by smaller units as inferior, with small firms being expected to more or less wither away. However, since the beginning of the 1970s the increasing role of small and medium sized enterprises (SMEs) in terms of employment and value-added has prompted a revaluation of the importance of SMEs.[9] In this chapter we will compare the size distribution of firms in Sweden with other industrialized countries. We will briefly review how the size distribution has emerged in different countries and review some of the explanations that has been forwarded earlier (sections 2.3 and 2.4). Moreover, we will also present a detailed study on the differences between small firms, subcontractors, and large firms, in order to asses the structural factors forming the capabilities and competitiveness of small firm production (section 2.5). In the proceeding chapters we will then empirically investigate some of the factors that seem crucial for international competitiveness, such as the skill composition of the labor force, the importance of economies of scale and the sources of scale effects. The chapter is concluded by a discussion on the prospects for small scale production (section 2.6).

[9] See Sengenberger, Loveman and Piore (1990), arguing that this trend started already in the end of the 1960s for most of the industrialized world. See also Burns and Dewhurst (1986) and OECD Employment Outlook (1985). Cantwell and Radaccio (1990) shows that on average the size of multinational firms has decreased. Carlsson (1989) showed that the role of the Fortune 500 firms in the US diminished in the 1980s. Also, Carlsson (1992) and Johansson (1997) analyzes the causes of the shift towards small business internationally and explores the consequences for industrial structure and competitiveness.

2.2 The shift toward SME-production in industrialized countries

Ever since Birch's (1979, 1981) seminal studies on SMEs - where it was concluded that approximately 80 percent of employment growth emanated from SMEs - attention has been directed towards employment effects of SMEs.[10] A comparative study of the development of SMEs in the industrialized world - in terms of primarily employment shares - was however first systematically analyzed by Sengenberger, Loveman and Piore (1990) and Burns and Dewhurst (1986). These studies both report an increase in the share of employment, despite bottlenecks in finance, managerial know-how, etc. In Sengenberg et al (1990), the authors set off with the following statement. "Just a decade ago the idea that small enterprises might be seen as the key to economic regeneration, and a road to renewed growth of employment and the fight against mass unemployment, may have seemed eccentric or even absurd. Today this view seems much less far fetched. On the contrary, many observers from different traditions and political orientations embrace the idea, though they may disagree on why and how small firm expansion and dynamism have arisen."

In all the countries covered in the studies mentioned above, an apparent shift towards smaller units of production in terms of employment in the postwar period is reported.[11] Moreover, in all countries - with one exception - this development coincides with a loss of the large firm's part of manufacturing employment. It is also remarkable how robust these findings are despite the differences between countries with regard to industrial structure, institutional setting, size distribution, different legal framework, tradition and history. However, although the trend is similar in various countries, the extent of SME growth differs quite substantially among the countries.[12]

In Tables 2.1 and 2.2 it is shown how the employment share of small enterprises and

[10] Birch's results were confirmed, and even reinforced, in a later study (Birch, 1987). See also Evans (1991).

[11] The countries are Denmark, France, Italy, Japan, Northern Ireland, Switzerland, The Republic of Ireland, The United Kingdom, The United States and West Germany. The same pattern is observed in Canada (Laroche, 1989).

[12] Data on establishments are often more reliable then firm data. In Sengenberger's et al study, data have sometimes been collected from different sources which may influence the time series. In Tables 2.1-2.4, small implies less than 100 employees while medium refers to less than 500 employees, if nothing else is stated.

establishments have evolved during the last three to four decades. Most countries seem to have experienced a shift towards smaller units in the late 1960s or in the beginning of the 1970s. This is particularly evident for establishment data on the total economy (Table 2.2).

As mentioned above, SMEs are most important in the service sector and the size distribution in the total economy may therefore be influenced by the expanding service sector. However, this compositional shift explains only part of the shift to smaller production units (Sengenberg et al, 1990). As shown in Table 2.3-2.4, even if the manufacturing sector is isolated, the tendency towards smaller units remains (with the exception of Switzerland), even though it is weaker. If establishment size is studied, the pattern is more clear-cut (Tables 2.2 and 2.4).

A picture of a movement towards decentralized organization structures emerges since both enterprise and establishment sizes are diminished. Furthermore, the authors argue that size in itself is not decisive for performance but rather the organization of production and the underlying structure in terms of policies, networks etc. There is no evidence that sectoral or cyclical factors determine the expansion of SMEs. Instead, the expansion of SMEs seems to be connected with increased heterogeneity in consumer demand and the implementation of new technology allowing flexibility and high quality production.

Table 2.1. Employment shares by enterprise size, time series for the total economy

Japan	**1965**	**1968**	**1971**	**1974**	**1977**	**1982**	**1985**
Small	53.7	55	55.9	57	58.9	60	
Medium*			70	70.4	72.7	73.1	73
United States	**1958**	**1963**	**1967**	**1972**	**1977**	**1982**	
Small	41.3	39.9	39.9	41.3	40.1	45.7	
Medium	55.1	52.9	53.2	53.5	52.5	58.7	
France			**1971**		**1979**		**1985**
Small			39		43.4		46.2
Medium			57.4		60.7		64.5
West Germany	**1961**		**1970**				
Small**	54.9		52.3				
Italy	**1951**	**1961**	**1971**			**1981**	
Small	60.2	63.5	61.6			69.3	
Medium	73	77.1	74.4			81.5	
Switzerland	**1955**	**1965**		**1975**			**1985**
Small***	52.5	45.4		46.1			46.3
Medium	82	78.9		77.4			73.4

Note: * 1-300 employees ** 1-200 employees *** 1-50 employees.

Source: Sengenberger et al (1990).

Table 2.2. Employment shares by establishment size, time series for the total economy

Japan		**1969**	**1972**	**1975**	**1978**	**1981**	
Small		70.1	71.5	73.8	76.1	77.1	
Medium*		83.1	84.2	85.6	87.5	88.3	
United States	**1962**	**1965**	**1970**	**1975**	**1978**	**1982**	**1985**
Small	51.3	51.5	49.5	54	54.4	55.1	55.9
Medium				76.9	77.7	78.6	79.8
West Germany			**1977**	**1979**	**1981**	**1983**	**1985**
Small			47	47.9	48.3	49.7	49.6
Medium			70.4	71.1	71.4	72.3	72.3
Italy	**1951**	**1961**	**1971**			**1981**	
Small	67.2	61.6	69.3			72.4	
Medium	82.6	82.2	85			87.3	
Switzerland				**1975**			**1985**
Small				66.2			69.3
Medium				88.2			89

Note: * 1-300 employees.

Source: Sengenberger et al (1990).

Table 2.3. Employment shares by enterprise size, time series for the manufacturing sector

Japan*	**1955**		**1972**	**1975**	**1979**	**1983**	
Small	57		43	45	49	47	
Medium	85		63	65	68	67	
United States	**1958**	**1963**	**1967**	**1972**	19771	**1982**	
Small	20.6	19.1	16.3	16.2	6.2	17.6	
Medium	37.1	34.5	30.4	28.9	29	30.3	
France			**1971**		**1979**		
Small			26.4		28.6		
Medium			49.5		50.6		
West Germany**	**1963**		**1970**	**1976**	**1980**	**1983**	**1984**
Small	14		12.5	13.1	15.4	16	16.2
Medium	39.6		37.3	38	40.4	40.8	41.1
Italy***	**1951**	**1961**	**1971**			**1981**	
Small	50.5	53.2	50.5			55.3	
Medium	67.4	72	69.2			73.9	
Switzerland		**1965**					**1985**
Small		34.8					29.7
Medium		71					69.4
United Kingdom			**1971**	**1975**	**1978**	**1981**	**1986**
Small			15.5	16.8	17.3	20.3	22

Note: * In 1955 small is defined as 5-99 employees and medium size as 5-999 employees. ** Handicraft is included in the figures for 1980, 1983 and 1985. *** Small is defined as 1-49 employees.

Source: Sengenberger et al (1990).

Table 2.4. Employment shares by establishment size, time series for the manufacturing sector

Japan	**1957**	**1962**	**1971**	**1977**	**1980**	**1982**	**1984**
Small	59	52	51	56	58	56	55
Medium*	73	68	67	71	74	72	72
United States			**1974**	**1978**	**19802**	**1982**	**1985**
Small			24.4	25.3	5.2	26.9	27.6
Medium			57.2	58.3	58.2	59.6	61.4
France	**1954**	**1966**		**1974**		**1981**	
Small	52	48		45		47	
Medium	75	74		72		73	
West Germany**	**1963**		**1970**	**1976**	**1980**		**1984**
Small	20		18.5	19.6	18.3		18.6
Medium	48.2		46.6	48.3	47.6		48.5
Italy	**1951**	**1961**	**1971**			**1981**	
Small	54.2	56.9	54.6			59.1	
Medium	74.6	78.5	76.9			80.3	
Switzerland	**1955**	**1965**			**1975**		**1985**
Small	43.6	37.8			38.4		33.3
Medium	80.1	76.8			78.3		77
United Kingdom	**1954**	**1963**	**1970**	**1975**			**1983**
Small	24.2	20.2	18.4	19.7			26.2
Medium	56.5	50.9	45.4	45			53.2

Note: * Medium is defined as 100-299 employees. ** After 1976 the figures include handicraft sector.

Source: Sengenberger et al (1990).

Burns and Dewhurst (1986) reports similar results where all except one country belong to the EC. Irrespective of whether countries are small or large a pattern of growing SME sectors is quite evident. Their result contrasts with the general assumption that the harmonization within EC has primarily benefited LEs. Moreover, the process of concentration observed in the 1950s and 1960s has, according to the authors, not only ceased, but also been reversed.

2.3 Evidence after 1980 on the size distribution of firms in industrialized countries

The following section gives a brief overview of the size distribution of firms in a number of European countries, with special emphasis on Sweden. The classification of firms on different sizes is based on the official general industrial classification system used by Eurostat (Commission of European Communities, 1992), which differ from the more crude definition previously used.[13] We will adopt the following size classification: micro (0-9 employees), small (10-99 employees), medium (100-499), and large firms (>500 employees). In the presentation of the Swedish statistics, up to nine different size classes will be used, covering the time period (1968-1993). In the comparison of the size distribution of firms in 12 European countries a somewhat less extensive time period will be implemented (1983-1991).

Commencing with 12 European countries, Table 2.5 gives the number and ranking of small firms per inhabitants for all sectors, while Table 2.6 report the corresponding figures for the industrial sector. With regard to the first table, the largest relative number of small firms are found in Luxembourg, Denmark and Germany while Italy, Portugal and Denmark have the largest population of small firms in the industrial sector. In both tables Sweden is ranked as having a comparatively limited number of small firms.

Looking at the overall distribution of firms, Sweden gains a top position in terms of large firms (Table 2.7). That holds for the total population as well as for industrial firms. Sweden is followed by Finland, France, Germany and United Kingdom when the total population is considered, and Belgium, Finland and the United Kingdom when it comes to industrial firms. Hence, the size distribution of firms differs quite dramatically between countries. Judging from the overall picture, it is obvious that the Swedish distribution of firms is distorted towards large firms.

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[13] This section relies heavily on Johansson (1997), who gives a detailed description of the size distribution of firms within the European countries and the pitfalls associated with statistics of SMEs.

Table 2.5. The number of small-sized enterprises/1,000,000 inhabitants, all sectors

Country	1983	1986	1988	1989	1990	1991	Average	Rank
Germany	3946	3976	4070		3925		3979	3
France	2238	2151	2238		2412		2260	12
The United Kingdom	3298	3365	2818	2841	3158	3084	3094	6
Sweden	2665	2800	2918	3012	3101	3074	2928	7
Italy	5179	5041	2235	2289			3686	4
Spain	2270	2278	2681	2984	2802	2828	2641	10
Belgium	2235	2226	2460	2582	2328	2408	2373	11
Portugal		2598			3257	3507	3121	5
Denmark			5220	5182	3005	2934	4085	2
Luxembourg	3329	3532	4286		4808	5207	4232	1
Finland			2830	2920	2896	2549	2799	9
Norway					2854		2854	8
Total	25159	27968	31757	21810	34546	25590		
Average	3145	3108	3176	3116	3141	3199	3147	

Note: In the last two observations for Italy, NACE 9, other services is excluded. The geographical coverage for Germany is the former Federal Republic of Germany. Belgium and Denmark have other reporting units than enterprise, e.g. establishments. The data for Belgium, Denmark, Spain, Italy and Luxembourg are produced using other sources of information in 1983 and 1986 than in the other years. Primary sectors are excluded. For Sweden, enterprises active in non-market services and public administration are included.

Source: Johansson (1997).

Table 2.6. The number of small-sized enterprises/1,000,000 inhabitants, industry
(ISIC 2-4)

Country	1983	1986	1988	1989	1990	1991	Average	Rank
Germany	1005	994	1203		1170		1093	4
France	670	646	649		689		663	10
The United Kingdom	590	613	688	672	637	603	634	11
Sweden	750	775	782	784	785	746	770	8
Italy	1651	1374	1341	1390			1439	1
Spain	958	925	975	1042	1058	1145	1017	5
Belgium	713	703	663	687	678	684	688	9
Portugal		1084			1449	1559	1364	2
Denmark	1345	1516	1305	1295	971	955	1231	3
Luxembourg	495	546	638		669	698	609	12
Finland			803	832	800	711	787	7
Norway			977	933	775		895	6
Total	8177	9177	10024	7634	9681	7101		
Average	909	918	911	954	880	888	910	

Source: Johansson (1997).

Table 2.7. The size distribution of firms in 12 EU countries, percentage, 1991

	All sectors			*Industry*		
Country	S	M	L	S	M	L
Germany	92.3 (5)	6.5 (8)	1.2 (6)	86.0 (7)	11.3 (6)	2.7 (6)
France	91.2 (7)	7.3 (6)	1.6 (5)	86.1 (6)	11.3 (5)	2.6 (7)
UK	89.7 (12)	8.7 (2)	1.6 (4)	84.8 (10)	11.9 (4)	3.3 (2)
Sweden	90.2 (10)	8.0 (3)	1.8 (1)	84.3 (11)	12.0 (3)	3.7 (1)
Italy	96.3 (1)	3.2 (12)	.5 (12)	94.5 (1)	4.8 (12)	.7 (12)
Spain	93.7 (2)	5.5 (11)	.8 (11)	92.2 (2)	6.8 (11)	.9 (11)
Belgium	90.7 (9)	7.6 (4)	1.7 (3)	85.0 (9)	12. 0 (2)	3.0 (5)
Portugal	92.3 (6)	6.8 (7)	.9 (10)	89.0 (4)	9.7 (9)	1.3 (10)
Denmark	93.4 (3)	5.7 (10)	1.0 (9)	88.7 (5)	9.8 (8)	1.5 (9)
Luxemb.	90.1 (11)	8.8 (1)	1.1 (7)	78.7 (12)	18.1 (1)	3.2 (3)
Finland	91.0 (8)	7.3 (5)	1.7 (2)	86.0 (8)	11.1 (7)	3.0 (4)
Norway	92.5 (4)	6.4 (9)	1.1 (8)	89.3 (3)	8.6 (10)	2.1 (8)

Note: S denotes small, M represents medium and L stands for large firms. Rank within parentheses.

Source: Johansson (1997).

Focussing at the size distribution of firms in Sweden, Table 2.8 reveals that for the overall population, the largest increases have occurred in the smallest and the largest size class over the period 1968-1993. Medium-sized firms has diminished over this period. This pattern is even stronger when the analysis is confined to the manufacturing sector. All size classes have experienced a decline during 1968-1993, except for the smallest class containing self-employed or one employee firms. The decline is strongest in the segments having 10 to 199 employees, while the decrease in the two largest size classes was about 50 percent lower (Table 2.9). This pattern of a decrease in predominantly the medium-sized firms is reinforced when the data set is corrected for state-owned enterprises and concerns (Johansson, 1997). It indicates a prevalence of factors that tend to deter growth of firms.

To summarize, Sweden turns out as being well endowed with large firms in an international comparison and ranks low with regard to the share of small firms. With regard to medium-sized firms, Sweden seems to be placed somewhere in the middle. On the other hand, looking more closely at Sweden's size distribution of firms over time, medium-sized firms have fared worse than other size classes. The most spectacular growth has occurred among the smallest firms. To get a clearer picture of the forces behind this growth, a more careful analysis of the motive behind entry must be considered.[10] Yet the overall picture indicates that Sweden is dominated by large firms as compared to other European countries, and that within Sweden the medium-sized firms have experienced a substantial decrease in the period 1968-1993.

Table 2.8. The number of enterprises/1.000.000 inhabitants in Sweden, 1968-93

Size class	1968	1993	Change 1968-1993 (%)
0-1	15474	39885	158
2-4	6232	7598	22
5-9	2587	3196	24
10-19	1404	1599	14
20-49	909	916	1
50-99	307	283	-8
100-199	152	141	-7
200-499	88	95	8
500+	57 (86)	92	61 (7)
Total	27210	53806	98

Note: From 1979 and on, county councils and municipalities are included in the statistics, which has a large effect on the number of large enterprises. The numbers in parenthesis show the number of enterprises and the change thereof if 1979 is used as base year. Data concerning the smallest size class are uncertain due to statistical problems.

Source: Johansson (1997).

[10] One interpretation of the pattern is that new firms have stayed small, i.e. the increase in 0-1 size class means that these are only part-time firms, and that the main source of income stems from employment in some other occupation. At the same time some of the medium-sized firms has grown into the large size classes, which diminish their percentages shares, simultaneously as the small firms stay small, i.e. there is no adding to the medium-sized classes.

Table 2.9. Enterprises/1,000,000 inhabitants 1968-1993, manufacturing

Size class	1968	Min Value	Min Year	Max. Value	Max. Year	1993	Change 1968-1993 (%)
0-1	945	782	1976	4081	1986	2725	188.26
2-4	806	682	1982	847	1990	780	-3.21
5-9	547	472	1983	561	1970	479	-12.48
10-19	410	281	1993	430	1970	281	-31.32
20-49	318	222	1993	325	1973	222	-30.03
50-99	124	90	1993	138	1970	90	-27.21
100-199	72	49	1993	75	1969	49	-31.11
200-499	42	36	1993	43	1970	36	-15.49
500+	30	26	1993	36	1989	26	-14.53
Total	3294					4689	42.35

Source: Johansson (1997).

2.4 Internationalization, knowledge, and specialization; evidence from a sample of Swedish firms

In this section structural differences across large, medium-sized and small firms are described. To achieve this end a comparison is undertaken between Swedish large firms and SMEs with regard to primarily the level of knowledge and internationalization, and to some extent the firms' degree of specialization.

The data used in the present study were collected through a questionnaire sent directly to a sample of 230 SMEs manufacturing firms. Small firms are defined as firms employing between 20 and 200 persons, while medium-sized firms have less than 500 employees and large firms are consequently defined as those with an employment level exceeding 500.[15] A special category in this sample are subcontractors, defined as producers of intermediate goods exposed to international competition where at least 20

[15] This database will also be implemented in some of the empirical studies to follow in the subsequent chapters.

percent of production goes to one customer. It turns out that the overwhelming majority of firms fulfilling these requirements fall in the category of medium-sized firms. Together with small firms they will be referred to as SMEs. The separation of small firms from subcontractors is motivated by the close links - or dependence - that encounter subcontractors as their customers become more internationalized, just-in-time deliveries gain in importance, etc. The underlying population for subcontractors is dispersed over several industries, although heavily concentrated to the engineering industry (particularly the transport industry). Some of the characteristics of the respective groups are revealed in Table 2.10.

Table 2.10. Average employment, turnover and rates of return for small firms and subcontractors, 1990

	Employment (annual average)	Turnover (million SEK)	Rate of return on total capital (%)	Gross margin (%)
Small firms	53	30	n.a.	9
Mediumsized firms	220	100	9.9	7.3

Source: Braunerhjelm 1991a.

2.4.1 Production specialization of SMEs

In our sample, small firms are specialized in relatively more sophisticated goods than medium-sized firms, often adapted to their customers specific requirements (Figure 2.1a).[16] Less then 50 percent of their production can be classified into standard component production or simple processing of raw material. The picture is quite different for medium-sized firms. Approximately 75 percent of their production falls into the production categorized as simple, requiring relatively little input of technology and skill (Figure 2.1b).

[16] For a detailed description of the production categories, see Braunerhjelm (1991).

Another characteristic feature of subcontracting firms is that they have a considerably closer link to large Swedish MNFs (2.2a). In a process of intensified internationalization of the customer firms, subcontractors encounter special requirements in their adaptation to the new conditions. They have to ponder whether they themselves should internationalize, i.e., follow their customers and set off a bandwagon effect, or seek alternative ways of serving their customers. An internationalization process is also coupled with considerable financial risks and requires special competence profiles among the employees, a matter which will be somewhat elaborated further below. The group of small firms seems to be in a quite different position as depicted in Figure 2.2b. The dependence on Swedish MNFs is much less pronounced in this case and the major part of customers belong to non-MNFs which are sited in the local environment.

Medium-sized firms, i.e. subcontractors, sell up to 80 percent of their production to Swedish MNFs. For more sophisticated producers of systems and investment goods, the role of Swedish MNFs diminishes but they still are the most important customer of subcontractors. Notably, most of the exports are within the group which produce systems, suggesting that these firms have developed a certain skill - niche production - on which they base their international competitiveness. In the small firm category, exports are generally lower and the smallest systems producers are closely tied to the Swedish MNFs. Hence, one interpretation is that the smallest systems producers initially supply the large, advanced customers on the home market and, as they become bigger, turn to the international market. Such a development could be explained in terms of lack of knowledge of the foreign market, striving to reduce risks and costs by taking advantage of their customers' relations, etc.

2.4.2 The knowledge base of small, medium and large sized firms

The database also contains information concerning the firms' knowledge base. Knowledge is a multi-dimensional concept and there is no generally accepted definition.[17] It includes competence in production, marketing, organization, distribution,

[17] For a discussion of business competence, its composition, and the evolution of the concept in the economic literature, see Carlsson and Eliasson (1991).

R&D etc., that is, all the elements that constitute the ability to run a business successfully. It will always be tacit to a certain extent, partly related to entrepreneurial capacity, but also due to luck and other non-measurable factors. Despite the difficulties associated with the measurement of knowledge, the questionnaire contained a limited number of variables related to specific knowledge variables. These were R&D expenditures, marketing and education expenditures and finally, the composition of the labor force within firms. In fact, for all of the knowledge variables a comparison will be made between large firms, subcontractors and small firms.[11]

In Table 2.11 the average expenditures on R&D, marketing and education - as reported in the firms' financial statements - are given. The difference between large firms and the SMEs is striking. R&D expenditures are six times higher in large firms than in subcontractors and about 11 times higher than in smaller firms. In marketing, although for the majority of large firms only domestic marketing expenditure is included, large firms display the highest expenditures, especially compared to subcontractors. This reflects the close links that subcontractors often have to a limited number of customers which makes marketing efforts less urgent. Education costs are more evenly dispersed between firms of different size, even though the SMEs report the smallest figures. On the other hand, as in-depth interviews with the firms reveal, less formal and more "on the job" training seems to be particularly important in the group of small firms.

[11] Data on large firms emanates from a survey to 260 firms in 1989 (Braunerhjelm 1990).

Table 2.11. R&D, marketing, and education expenditures as percentage of total costs in small firms, subcontractors and large firms, 1990

	R&D	Marketing	Education
Small firms	.8	4	.3
Subcontractor	1.5	3	2
Large firms (1989)	9	5	2

Source: Braunerhjelm, 1990, 1991a.

Table 2.12 attempts to capture the knowledge base of firms from a somewhat different angle, that is, through the differences in the composition of the labor force in the three groups of firms. The five skill categories are ranked in descending order with regard to competence, defined as their profession status, not formal training and education. Notably, large firms have more than 40 percent of their labor force in the three higher skill categories whereas subcontractors are dominated by the least skilled employees.

Table 2.12. The skill composition of the labor force in small firms, subcontractors and large firms, 1990

	Small	Subcontractors	Large firms (1989)
Executive staff	5	3	2
Specialists, middle management	9	7	11
White collar	16	15	29
Skilled worker	46	35	25
Unskilled worker	24	40	33
Total	100	100	100

Source: Braunerhjelm, 1990, 1991a.

The interpretation is that large firms, working in highly competitive international markets, are dependent on a large and sophisticated internal "service" sector, necessary to sustain and upgrade their international competitiveness. It is within these services activities that strategic competencies and competitiveness are created. Areas like marketing, finance, computer knowledge, logistics, and R&D, are of crucial importance. If these functions are necessary for international competitiveness, then the gap between large firms and particularly subcontractors is obvious. Note that the small firms are more abundantly endowed with skilled personnel than subcontractors.

2.4.3 Internationalization

In marked contrast to the ample studies on the internationalization of Swedish large firms (Swedenborg, 1979, 1986; Andersson et al, 1996; Braunerhjelm and Ekholm, 1998) less attention has been directed towards SMEs. Our final structural variable, the degree of internationalization, shows marked differences between firms of different size classes. Two variables are normally implemented to measure internationalization; export intensity and the extent of foreign production. As regard the latter variable, the extent of foreign production, it is well-known that large Swedish firms have since long had a substantial part of their operation located abroad. In 1994, Swedish multinationals firms had on average about 70 percent of their employees abroad (Braunerhjelm and Ekholm, 1998). For obvious reasons, foreign production by SMEs is modest, in 1990 it was estimated to account for between .5 an 1 percent of their production, and more than 95 percent of their employment is in their home country units. Still, over the last 30 years the number of Swedish small firms (less than 200 employees) with production abroad has quadrupled (Table 2.13).

Table 2.13. Number of Swedish small MNF with production units abroad

Year	1965	1970	1974	1978	1986	1990	1994
Number of firms	8	7	9	15	18	23	32

Source: IUI surveys 1965, 1970, 1974, 1978, 1986, 1990 and 1994.

Similarly, export performance differs quite markedly among the three groups of firms. On average, large Swedish firms exported between 65 and 70 percent of their production in 1994, while exports by Swedish SMEs account for approximately 20 percent of their total sales, with wide differences among firms within the SME group. The most important market is the European Union (EU), receiving between 65 to 80 percent of the SMEs' exports. In the beginning of the 1990s, the export share to EU has increased for SMEs in the late 1980s and beginning of the 1990s (Table 2.14).[19] This partly reflects that the massive FDI undertaken by Swedish MNFs during the 1980s into the EC has had a pull effect on exports from the domestically located subcontractors, and partly the greater attention paid to, at that time the expectation of a future integrated European market.

Table 2.14. The distribution of SME exports on different regions, percentage, 1988-1990 and 1993

	EU*	Nordic countries (except Denmark)	Rest of the World
1988	59	17	24
1989	59	15	26
1990	64	16	20
1993	82	15	3

Source: Braunerhjelm (1991a), Carlsson and Braunerhjelm (1994).
Note: *With the exclusion of the Nordic countries.

Overall, and in accordance with earlier empirical studies and the theoretical approach emphasizing firm-specific assets, it seems as if firms with some unique capability or knowledge, have been most successful on the international market. More specifically, medium-sized firms, often subcontractors, are stuck with problems of a more structural character than small firms in general. They are more deeply involved in production of relatively simple components that do not require any particular skill or knowledge, largely dependent on Swedish MNFs, their internationalization degree is

[19] Data is only available for medium-sized firms.

quite low, and they seem to lack the resources required to develop their inhouse R&D-capacity. In fact, the R&D-intensity fell between 1990 and 1993 (Carlsson and Braunerhjelm, 1994). The latter circumstance is also true for the smaller firms but, since their customers are more local, it is of less concern. Moreover, medium-sized firms employ by far the largest proportion of unskilled labor and also display a lower profit performance then the other groups. Their problems are further aggravated by their customers' attempt to outsource part of the R&D activities on subcontractors at the same time as reductions in prices are demanded. To embark on internationalization, or to move production into more specialized and sophisticated segments, constitute a very delicate tasks under these circumstances.

2.5 Some concluding remarks

Much of the 1950s and 1960s were characterized by the establishment of large scale production units, designed for mass production of standardized goods. Organization of production followed Tayloristic and Fordistic principles, resulting in bureaucratic and hierarchic structures. Strategies to develop and sustain the competitive edge of firms was predominantly geared to low costs while less attention was paid to differentiation and quality. This trend came to a halt in the late 1960s. Demand shifted towards more differentiated, high quality products. At the same, internationalization of production came into a more intensified phase through the dismantling of trade barriers, continued integration efforts, and the improved and less expensive transportation systems. This led to a stiffening and widening of competition to sectors formerly shielded from international competition. Traditionally home market orientated firms in industrialized countries hence became more exposed to foreign competition.

The last two to three decades have also been characterized by an impressive revival of SMEs in terms of employment shares, creation of value added and profit levels. The specific strongholds of SMEs are customization and prompt deliveries, paired with flexibility and related services (Storey, 1996). Furthermore, smaller units are claimed to attain higher cost efficiency as well as having flatter, non-bureaucratic, organizations and highly motivated personnel (Pratten, 1991). As technologies during the last decades have been adapted to suit small scale production, SMEs are often better equipped to encounter heterogeneous and volatile demand with their closer and more direct links to the market. But new technology also imposes constraints on the SMEs due to increased demand for human capital encompassing the knowledge required to handle the more advanced technology.

Technological progress and intensified competition seem to be two factors that have influenced the development of novel production modes, i.e., networks (broadly defined), technological systems and alike production structures. Even though this indicate a disintegration of the traditional firm, such systems are built on close and frequent interaction, mutual dependence and confidence among the participants. Networks are claimed to increase flexibility, induce a higher sensitivity to the price mechanisms and to enhance learning (Asanuma, 1991). As networks, and network externalities, are judged to become strategically more important, they will also influence the pattern of FDI. Clustering is likely to occur (see Chapters 5 and 6) since the location of large customer firms will be more influenced by such non-traditional factors as the regional composition of firms, skill levels, education etc. In addition to the possibility of exploiting network externalities this will induce SMEs to undertake FDI in certain areas. Examples are the clustering of biotech firms in the south of France, the textile industry in the north of Italy and the regional clustering of part of the engineering tool industry in Germany. From such regional clustering of specific capabilities and competencies, a pattern of regional comparative advantage is likely to emerge.

Most of this is promising for the future of small firms. Their flexibility enables swift reactions to changes in demand and in addition the local presence often certifies that service and maintenance can be supplied adequately. As international competition intensifies, SMEs can exploit their strength of small, flat organizations and flexible organizations, promoting high "economies of learning". All these factors seem to be positive for SME production, although there are some caveats to this story. First, past evolution of SMEs is blurred by the fragmented knowledge on the birth and death of firms and its effect on the distribution of firm size. If mainly large enterprises exit from the market it would render the impression that SMEs increases. Related to this is the question of "externalization", networks and how subsidiaries are treated in the statistics. Further, it should be noted that the changes in size distribution are measured in terms of employment. Obviously, if a large firm substitutes labor for more capital intensive techniques, while production remains constant, it is hard to argue that the firm has diminished in size (Carlsson, 1992; Carlsson and Taymaz, 1992). Hence, employment measures should preferably be complemented with other measures.

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CHAPTER 3

3. On the role of knowledge capital in firm performance

- Empirical evidence from Swedish firms in the engineering industry[20]

3.1 Introduction

Although its importance was first recognized long ago, the role of knowledge in firm performance has recently been rediscovered as a key to economic prosperity.[21] That goes for the micro level (Eliasson, 1990; Grant, 1991) as well as the macro level (Romer, 1986; Grossman-Helpman, 1991). Still, most economic models tend to ignore knowledge factors or classify them as residual effects. If knowledge is incorporated at all, it is generally restricted to R&D investments, although activities like organizational routines, education, networks, marketing, supporting systems, etc., all form the base of the knowledge stock of a firm or country (Nelson-Winter, 1982; Spencer-Valla, 1989; Porter, 1990). As pointed out by for instance Freeman (1994) "it is often unsatisfactory to use R&D expenditure statistics as a surrogate for all those activities at the level of the firm which are directed towards knowledge accumulation, technical change and innovation. We have measures of 'capital-intensity' and of 'energy-intensity', but not of 'knowledge-intensity'".

The purpose of this chapter is to conceptualize knowledge capital and to incorporate it into a simple model of the firm, from which hypotheses concerning the relation between profitability and knowledge capital will be derived and empirically tested. The analysis differs from previous research in that it introduces a stock variable that more closely corresponds to the theoretically derived concept of firm-specific assets. In addition to R&D-investments, it also comprises investments in marketing, education and software. The empirical analysis is based on a unique firm data set emanating from

[20] A version of this paper has been published in the Revue d'Economie et Industrielle.

[21] Marshall wrote already in 1879 that "knowledge is the most prominent engine of growth". Hayek (1945) also stressed the importance of knowledge and the measurement difficulties.

extensive surveys carried out by the Research Institute of Industrial Economics (IUI).[22]

The chapter is organized in the following way: The definition of knowledge capital is presented in the next section (section 3.2). A simple model of knowledge based, profit-maximizing firms is presented in section 3.3. The hypotheses derived from the model are specified and empirically tested in section 3.4. Finally, the main results are summarized and some normative implications discussed (section 3.5.).

3.2 Knowledge capital

The importance of knowledge has been recognized in several fields of economic research, e.g. the theory of human capital, the impact of public goods, and the recent contributions to growth theory (Knight, 1921, 1944; McKenzie, 1959; Arrow, 1962; Kendrick, 1976; Griliches, 1979; Romer, 1986; Sala-i-Martin, 1990; Becker, 1994; Eliasson-Braunerhjelm, 1997). Yet, being an intangible good, most attempts to incorporate it explicitly into the production function as a factor of production have been frustrated. Despite the impressive theoretical achievements, empirical evidence remains quite scarce.

To assess the influence of knowledge on firm performance, a stock concept of such assets has to be developed. But investments related to knowledge assets are, in accordance with the existing legislation and conventions, booked directly on the firm's expense account. This means that empirical analyses run into considerable computational, definitional, and methodological problems since knowledge stocks have to be constructed. Furthermore, knowledge will always contain elements of tacitness related to entrepreneurial skill, luck and other non-measurable factors. Still, as argued by for instance Eliasson (1992), much of the same difficulties arise when investments in real capital are undertaken. Moreover, the growth of knowledge assets within firms strongly suggests that such assets cannot be omitted from economic analysis (Bryer 1990).

One question addressed in the knowledge literature concerns the differences in profits between firms. Even within narrowly defined industries wide dispersions in

[22] For a detailed description of the survey, see Braunerhjelm (1992).

profit rates can be found, violating the standard assumption of equalization of profits. Such differences have been shown to persist over long periods of time, and one cannot simply refer to them as temporary divergences from equilibrium (Shepherd, 1975; Chandler, 1990; Mueller, 1990). Scherer (1986) argues that firms that manage to build up a "reputational capital" can charge a premium due to such capital, or expand their customer base at a lower price compared to their competitors. Other studies confer the main explanations to collusion and structural entry barriers, particularly tariffs and market dominance (Bain, 1955; Collins-Preston, 1968; Shepherd, 1972; Demsetz, 1973; Porter, 1974; Weiss, 1974; Carter, 1978; Ravenscraft,1983; Mueller, 1990). The persistent profit argument seems, however, to be at least partly based on wrongly specified models since most studies only consider surviving firms, i.e. they do not account for sample selection bias. Those firms that fail and exit do not show up in the data sets.

Somewhat surprising, less attention has been paid to the effects of investment in intangibles in explaining the incidence of profits across firms. One explanation is of course the lack of good data on accumulated investments in intangible knowledge assets such as R&D and marketing. The relatively few empirical studies that exists are predominantly based on industry data, where the applied lag distributions frequently are assumed identical across firms, and even industries. The conclusion from most of these studies is that a strong and rather immediate relationship exists between marketing and profitability (Boyer, 1974; Ayanian, 1975; Lambin, 1976; Comanor-Wilson, 1979). Block (1974) and Weiss (1974), however, report opposite findings. For R&D expenses, a positive effect has been found in most empirical studies, although it appears with a considerable lag (Branch, 1974; Ravenscraft-Scherer, 1982). But also here the evidence is ambiguous. For instance, Megna-Mueller (1991) finds weak support for R&D as an explanatory variable of profits.

With regard to the definition of knowledge there is at present no generally accepted definition of intangible capital, nor means of denominating it. "Knowledge capital" seems to be the most frequently used term, even though the literature also refers to "intangibles", "competence capital", and "soft capital," to name a few. Since knowledge alludes to abilities within the firm, both organizational and collective, as well as individual, we will adopt the following and somewhat more extensive definition of knowledge capital:

Knowledge capital of firms is defined as accumulated assets in R&D, marketing, software and education, where the returns are appropriated by the firms themselves.[23] The chosen items that constitute knowledge capital are consistent with the definitions of intangible assets analyzed separately in other studies. They all have a close links with skills and new technology. In addition to the frequently imposed variables R&D and marketing, we also include investments in education and software. The motivation is that these knowledge categories have a direct bearing to knowledge content of the firm as an organizational entity, where part is codified and easily accessible to other economic agents whereas other parts have a more tacit nature and are appropriated by the firms themselves. In contrast to much of previous studies in this field, where knowledge is assumed homogenous across firms, or even across industries, the above definition emphasize the firm-specific aspect of knowledge capital.[24]

This definition is operationalized by accumulating costs earlier charged on the current cost account. Costs with short-run effects (less than one year) are not activated as asset values, and all assets are expressed at reproduction value. The firms in the survey have themselves identified the investments whose returns they have appropriated, i.e. the measure of knowledge stocks is a subjective one.

3.3 A simple model of knowledge endowments and firm performance

The market structure in which firms operate is assumed to be characterized by imperfect competition and firms are assumed to be profit-maximizing and employ regular production technologies. How successful firms are depend on to which extent they can differentiate their product from those of their competitors, a process in which the exploitation of their knowledge capital is crucial. The degree of differentiation, or uniqueness, generates temporary monopolies which shows up in higher profits.

Models incorporating intangible assets are generally based on either the assumption

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[23] Becker (1994) refutes the idea that firms underinvest in training due to the risk that their employees may leave the firm. Instead, workers accept lower wages for training.

[24] Grossman-Helpman (1991) use a similar approach, separating between specific technological information and general technological information.

that such investments shifts a firm's demand function (Clarke, 1976; Megna-Mueller, 1991), or that intangibles act as a shift factor in the production function (Griliches, 1979; Romer, 1986). It is the latter approach that is adopted here. Profits, defined as residual revenues not distributed to labor and real capital, will be derived from this approach.

Consider the following basic structure of production of a representative firm (i). All firms employ three factors of production, labor (L), capital (K) and a composite knowledge capital (H). Perfect competition prevails on the factor markets for capital and labor, while H is firm-specific, heterogenous, and contained within the firms. Production is organized such that upstream, firm-specific knowledge capital (H) shapes and adds value to downstream production by differentiating it from other close varieties. Homogeneous capital (K) and labor (L) are employed in downstream manufacturing, on which knowledge capital acts as a shift-factor.[25]

Assume that all firms organize production by means of identical Cobb-Douglas technologies,

$$Q_i = AK_i^{1-\alpha}L_i^{\alpha}H_i^{\gamma} \qquad (3.1)$$
$$0 < \alpha,\gamma < 1$$

The restriction on γ is imposed to assert that firms cannot handle unlimited amounts of H, i.e. decreasing returns to H is postulated. The production function Q is hence assumed to be linearly homogenous in capital and labor, but to exhibit limited increasing returns to scale with regard to all factors.

As modeled, the production function is strongly separable, implying that it can be divided into a constant returns to scale part ($V_i=AK_i^{1-\alpha}L_i^{\alpha}$) and an increasing returns to scale part H_i^{γ}. Profit (Π) is then defined as

$$\Pi_i = P(V_iH_i^{\gamma}) - W_iV_i - R_iH_i \quad \geq 0 \qquad (3.2)$$

where the unit costs of the linearly homogenous input aggregate (V_i) is denoted W_i

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[25] Already Knight (1921) objected to the idea that increasing returns to scale were external in all respects to firms.

while R_i represents the reward to each firm's knowledge capital H_i.[26] If H_i were a well-defined production factor within the firm, all residual profits (R_i) would be appropriated by that factor. Here it could be interpreted as the returns to owners or to entrepreneurial skill, frequently disregarded in economic models. It must be non-negative since firms cannot operate at negative profits.

Profit maximizing can be viewed as a two-step procedure. First, the optimal quantities of capital and labor are determined for given prices and a given stock of H_i, where profit is known to be zero. Thereafter, profits are maximized with respect to H_i, which is the step we focus on here. The equilibrium stock of knowledge capital for firm i is calculated by maximizing equation 3.2 subject to the restrictions in equation 3.1. Hence, differentiating profits with respect to H_i, yields the first order condition[27]

$$\Pi_{i,h} \equiv P\gamma H_i^{\gamma-1}V_i = R_i \tag{3.3}$$

or, by (1) and the definition of V_i

$$\gamma Q = r_i H_i \tag{3.4}$$

$$(r_i = R_i/P)$$

implying that knowledge capital is employed until the marginal contribution of additional H equals the marginal (real) return demanded by the firms' owners, which is either distributed to owners or show up as profits.

The second order condition implies falling returns to H after some optimum stock of knowledge capital is reached,

$$\Pi_{i,hh} = (1-(1/\gamma))P_i V_i H^{\gamma-2} \quad < 0 \tag{3.5}$$

which is unambiguously negative since $0<\gamma<1$. Consequently, the marginal effect of

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[26] In general, if a constant return to scale technology prevails, the cost function can be written as c(w,y)=yc(w,1) which is utilized in equation 3.2.

[27] Subscripts denote partial derivatives, except for numbers (or t) that refer to periods, or i, which refers to firm i.

knowledge investments peters out and at some stage goes to zero.

3.4 Data, hypotheses, and empirical results

To acquire data on knowledge capital, normally not reported in the firm's annual reports, several methods are available. First, growth accounting can be utilized to isolate the impact of R&D on outputs.[28] Second, the stock of knowledge capital can be calculated by gathering information from the firms directly through interviews and questionnaires or in close collaboration with, the firms themselves. This is the approach taken here.[29] Of course, also this method can be claimed to be arbitrary and it is doubtlessly based on a subjective evaluation. However, the values are at least based on estimates coming directly from the firms, i.e. those who should be best at evaluating these values. Each value has been thoroughly checked in interviews with each of the participating firms.[30]

This method has some obvious advantages. First, we can disregard the lag-problem. At present, there is no consensus concerning the lag structure. For instance, in capitalizing R&D expenditures Terleckyj (1982) used a three-year lag, while Pakes-Schankerman (1984) and Griliches-Lichtenberg (1984) implemented a two-year lag. Several other lag structures are also used. Furthermore, we avoid the difficulties

[28] Growth accounting implies that the growth of inputs (k and l) is subtracted from the growth of output which yields the multifactor productivity growth. It can be used to isolate the effect of R&D. Consider the following Cobb-Douglas production function (q), where all variables are expressed as percentage rate of change,

$$q - \alpha_1 k - \alpha_2 l = a + \alpha_3 r$$

Productivity growth is decomposed into a constant and the effect of R&D(=r). The underlying assumption is that each factor's contribution to output can be determined by multiplying its income share by its rate of growth, i.e. each input is taken to be paid exactly its marginal product.

[29] The question concerning knowledge capital was formulated in the following way: "Please quantify the firms accumulated assets in R&D, marketing, software and education, either by giving the value directly in Swedish krona, or as percent of fixed assets. Values should be calculated as accumulated investments in above categories, after depreciation and in repurchase prices."

[30] Information gathered through interviews has sometimes been claimed to be unscientific. Commenting on that controversy, Scherer (1986) makes an analogy to the difficulties that astronomists encountered in the 17th century in determining the shape of the planetary orbits. Kepler, unable to observe the planetary motions, assumed that they were circular. However, when he visited Tycho Brahe he could actually observe that the orbits were elliptical, which impelled Scherer to make the following remark; "If Kepler could have interviewed God about what laws of planetary motion He ordained, would he have refrained because it was unscientific? One doubts it."

stemming from different assumptions with regard to the depreciation rate of R&D. Also here opinions differ. Terleckyj (1982) argues that the most reasonable results are obtained if no depreciation at all is assumed, while others claim that yearly depreciation is more likely to be around 20-30 percent (Pakes-Schankerman 1984). Related to this is the problem of obtaining an estimate of the R&D-stock in real terms, where again there are numerous recommendations. In essence, what this tells us is that the calculations of R&D stocks are plagued by a number of difficulties which will, to varying degrees, insert errors into the estimates.[31]

3.4.1 Hypotheses

The empirical application will be based on the simple model outlined above. Rather than subjecting the model itself to a rigorous test, the basic hypothesis to be empirically tested is derived from the theoretical model. In particular, our analysis is constrained by the fact that our database alludes to one single year of observation. Heterogeneity, and free entry of firms, imply that in a given year firms are likely to be in different phases regarding their accumulation of knowledge. We therefore expect a positive relation between firms' endowment of knowledge (H) and their profitability. The intuitive explanation is the following: firms engage in product differentiation to maximize profits, whereby a firm's ability to undertake such differentiation depends on its accumulated skills and know-how, i.e. its knowledge stock. A larger knowledge stock is claimed to facilitate the integration of new technology into the firm's production process as well as the upgrading of its existing technology. Furthermore, knowledge as defined above, should improve the firm's possibility to respond to alterations in consumer preferences.

If there is no well-defined factor to appropriate the return to such knowledge, returns will show up as residual profits or Schumpeterian rent. On the other hand, if labor managed to appropriate all of the returns to knowledge, that would have a negative impact on the firm's profitability. Hence, we expect a negative relationship between costs of labor (W) and profitability.

A few control variables, where previous research has established a relation to

[31] For a survey of these problems, see the study by the US Department of Labor (1989).

profitability, will also be included into the empirical analysis. First, to attain a certain scale is often regarded as necessary in order for firms to become profitable. Thus, size (S) - measured in terms of labor or sales - is asserted to be positively related to profits. Furthermore, in small countries, large firms can be expected to be dependent on the international market to sustain profits. Therefore, in addition to exports (X), a size-weighted relationship between profits and exports (XL) will also be incorporated into the analysis.

Similarity, market power (POWER) has frequently been invoked to explain differences across firms in profitability. Market dominance allows monopoly pricing to a larger extent and is also an indication of how successful firms have been in impeding entry by other firms. Therefore we expect market power to be positively connected with profits. Finally, we control for productivity (LP) since in order to make profits, a firm's ability to differentiate its product must be parallelled by a productivity level which is comparable to its competitors.

3.4.2 Econometric specification and results

The sample consists of 150 firms in the engineering industry (ISIC 38), randomly chosen by SCB (Sweden Statistics). Out of the 150 firms, 13 were excluded because of changes in production, exits, etc. The remaining 137 firms were compared against industry averages to make sure they constituted a representative selection. The data collection was undertaken by IUI, mainly through extensive surveys, and to some extent complemented by data from public sources. All data refers to 1989.

The endogenous variable is the firm's real profit margin (Π_i), defined as sales revenue minus total costs. In accordance with discussion above, and the theoretical model in section 3, the following general functional relationship is postulated:

$$\Pi_i = f(\underset{+}{H},\underset{+}{S},\underset{?}{X},\underset{+}{XL},\underset{+}{POWER},\underset{+}{LP},\underset{-}{W})$$

All variables have been deflated by the consumer price index and divided by total capital to avoid problems of heteroscedasticity and to isolate them from effects of firm size. This implies that the dependent variable also can be interpreted as the real rate of return on total capital (ε_i). From correlation matrices there is no sign of multicollinearity. The hypotheses formulated above will be tested by applying OLS estimation to a logarithmic form of the profit-function,

$$\varepsilon_i^* = a + b_1 h_i + b_2 s_i + b_3 (xl)_i + b_4 x_i + b_5 power_i + b_6 (lp)_i - b_7 w_i + \eta \qquad (3.6)$$

where ε_i^* denotes the rate of return inclusive of the hidden unknown return to knowledge capital. The error term is expected to exhibit standard properties, $\eta \sim N(0,\sigma^2)$ and $E(\eta_i \eta_j)=0$ for $i \neq j$.

The effect of knowledge (h) is tested by implementing predominantly stock variables.[32] Among these, SOFT1 refers to the stock of knowledge capital - as defined above - of firms, while the variable GR&D, defined as current R&D expenditure divided by the R&D-stock, denotes the growth in the R&D stock. Alternatively, the skill structure of firms (SKILL), which is a more commonly used knowledge proxy, is implemented to see to what extent the explanatory power differs between these two variables.[33] As expected, several tests with flow variables failed to show any significance. Stock variables are preferred since the effects of building up current knowledge through, for instance, R&D appear with a significant lag and only a fraction of current expenditure will eventually add to the stock of knowledge. Size (s) measured as numbers of employees, sales, or assets were also included. In all cases they were found to be insignificantly connected to the rate of return. Although evidence is somewhat mixed, this is consistent with a number of other studies (Burns-Dewhurst 1986, Braunerhjelm 1991). Instead, size was used as a weight to test whether foreign sales increase in importance for profits as firms become larger,

$b_x x$, where $b_x = (b_{x1} + b_{x2} l)$

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[32] Some overlapping of current costs and capitalized items is inevitable. As noted by Griliches (1973), since the inputs of capital and labor includes the factors of production used in R&D, the social rate of return is beyond the private rate of return (see also Griliches-Lichtenberg, 1984).

[33] The employees of the firms have been divided into five different skill categories. The variable SKILL refers to the second and the third category, i.e. specialists, technicians and employees in other service-oriented activities within the firm (see Braunerhjelm, 1992).

where l and x refer to employees and exports, respectively. If the hypothesis is supported, the parameter of the size weighted exports (b_{x2}) should be significant, while it is more difficult to a priori attach any sign to b_{x1}. Market power (POWER), measured as the firm's percentage of total sales in the engineering industry, i.e. market share, was also included since previous studies claim it to be an important explanatory variable of high profits.

The costs of homogenous factors (w) were approximated by the firm's labor costs (including social costs). Finally, labor productivity (lp), defined as value added per employee was included as an explanatory variable. To some extent it also captures the type of production within the firm.[34] The expected signs of the explanatory variables are summarized in Table 3.1.

The results are shown in Table 3.2.[35] In the first model (Model 1), where the implemented knowledge stock is SOFT1, all variables are significant at the 1 percent level, with the exception of the growth of the R&D stock (significant at the 5 percent level). Only the market power variable is insignificant. This is probably related to the relatively small size of the sample in relation to the total engineering industry. Hence, there is strong support for a positive relationship between firms' profitability and the stock of knowledge capital.

Exports by large firms have the expected positive sign and are significant while "pure" exports display a negative impact on profits. This could be interpreted as follows: large firms are dependent on exports to sustain profits, while small firms, experiencing lower profits as they engage in export activities, do not possess the competence required to operate on the international markets.[36]

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[34] Value added could also be used as a measure of a firm's knowledge endowment. The drawbacks are, however, that such values also incorporate effects of protectionism, regulations, etc. Furthermore, a cross-sectional study only includes data for one year. To be able to interpret value added as a knowledge variable, data would be required over the whole business cycle in order to adjust for peak values. The same problem does not arise with stock values which are more stable over time.

[35] The different items composing knowledge capital (see definition) were also exposed to a principal component analysis with no improved result. A Hausman test, undertaken to control for the causality between profits and knowledge capital, showed no significance for the opposite causality.

[36] This is in accordance with interview results from smaller firms where it was claimed that the export market was used as a dumping market for production surpluses (Braunerhjelm, 1991).

In the second model (Model 2) the knowledge stock has been replaced by a more mainstream knowledge variable, i.e. SKILL, which captures the share of highly educated employees within the firms. It is also significant, albeit at a lower level. This is not surprising, considering that it is a less encompassing concept of knowledge, as compared to the variable SOFT1. Remaining variables seem robust with respect to parameter estimate and significance level, with the exception of growth of the R&D stock which fail to reach significance. For both models the adjusted R^2 values, as well as the F-values, are quite satisfactory.

3.5. Conclusions

In the above analysis, we have studied the relation between firm profitability and knowledge stocks, implementing a unique IUI data-set which captures firm-specific assets in a more direct way than traditional data on R&D and marketing. A static approach was pursued since in the empirical analysis we were confined to a cross-section data-set of firms in the engineering sector for a given point in time. Of course, a more dynamic approach would have been preferable considering the dynamic nature of knowledge itself. Despite the limitation of the model, we believe that the analysis yields valuable insights as regards the role of knowledge in firm performance.

Noteworthy and strong support is found for a positive relationship between profitability and the stock of knowledge capital on one hand, and profitability and exports in large firms on the other. The first findings contrasts with, for instance, the results reported by Megna-Mueller (1991). The second result highlight the heavy dependence of large firms on foreign markets to sustain profit levels. For smaller firms an opposite relation is indicated; exports tend to lower profits. No statistical significance was found for a relationship between size and profitability.

If we believe that profits over time transfer into positive welfare effects through e.g. wealth accumulation, higher investments and wages, then it is obvious that economic policies should be geared toward knowledge accumulation. Such policies could however only lay down the basic prerequisites for firms by providing advanced high-quality education, competitive infrastructures and communication systems. The firms themselves, through their acquired knowledge and in competition with other firms, have to determine the allocation and composition of their knowledge capital.

Table 3. 1. Definition and expected signs of explanatory variables

Explanatory variables	sign
SOFT1, amount of knowledge capital per labor unit	+
SKILL, percentage of skilled employees	+
GR&D, current R&D expenses divided by the R&D stock	+
X, absolute value of exports	+/-
XL, absolute value of exports weighted by labor	+
W, total labor costs	-
LP, labor productivity defined as value-added per employee	+
POWER, percentage sale of total domestic sale	

Table 3.2. Profitability and knowledge capital, 1989

	Dependent variable, profitability	
Independent variables	Model 1	Model 2
Intercept	.37 (.15)	.35 (.13)
SKILL		.21* (1.67)
SOFT1	.16*** (2.61)	
GR&D	.09** (2.12)	.02 (.64)
EXP	-2.84*** (-8.99)	-2.86*** (-8.79)
EXPL	2.82*** (8.80)	2.87*** (8.70)
LCOSTS	-2.32*** (-8.50)	-2.42*** (-8.21)
LP	2.77*** (8.77)	2.88*** (8.91)
POWER	.21 (.99)	.23 (.96)
Adj.R^2	.70	.68
F-value	23.3	21.4
DF DW	129 2.3	128 2.4

Note: The-statistics are within brackets.* = 10 percent significance level, ** = 5 percent significance level, *** = 1 percent significance level.

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CHAPTER 4

4. Sunk costs, firm size and internationalization[12]

4.1 Introduction

Sunk costs have long been recognized as a key determinant as regards the size distribution of firms and, consequently, the market structure. According to the traditional "structuralist" view, market structure and the degree of concentration is determined by different entry barriers, such as R&D and marketing expenditures (Bain, 1949 and 1955; Lall, 1980). As suggested by Sutton (1991), we can think of these expenditures "as sunk costs incurred with a view to enhancing consumers' willingness to pay for the firm's product(s)" (Sutton, 1991, pp. 7-8).[13] Hence, in order for firms to develop, sustain, and finance such costs, it has been claimed necessary to reach a certain critical scale in production. Empirically this view has also received some support (Greenhalg, 1991; Kravis & Lipsey, 1992).[14]

More recently, the question of whether sunk costs are endogenously or exogenously determined has been addressed. A simplistic description of the mechanism separating endogenous from exogenous sunk costs imply that in the former case sunk costs - and the firm - tend to grow in proportion with the size of the market. This is held to primarily be the case for firms with extensive outlays on R&D and marketing expenditures. As these firms increase their sunk costs in response to market growth, thereby preserving their market share and their profits, the market structure remain

[12] A previous and less extended version has been published in the Economic Letters (Braunerhjelm, 1996).

[13] The difference between fixed costs and sunk costs is "one of degree, not of nature" (Tirole, 1994). One distinction is based on the length of the period that the costs are incurred. Fixed costs are the claimed to appear in the short- to medium-run, while sunk costs cannot be recouped and produce a stream of benefits over a longer term.

[14] For a review of this literature, see Cohen&Levin (1989). Although most studies confer a positive connection between concentration and R&D, some end up with the opposite conclusion. For instance, on firm level, Cohen & Movery (1987) find no positive connections between size and R&D-intensities. The alleged causality from size to R&D has rightly been criticized on grounds that a simultaneous relationship between firm size and R&D-expenditures is more likely to prevail (Dasgupta & Stiglitz, 1980; Caves, 1996; Fors, 1997).

thereby preserving their market share and their profits, the market structure remain relatively invariant to changes in markets size (Sutton, 1991; Schmalensee, 1986 and 1992). This has been shown to hold for a surprisingly large number of different oligopoly models, irrespective of which type of game that is pursued (Sutton, 1991).

In a parallel strand of economics, which is also preoccupied with the impact of outlays on sunk costs and firm growth, a somewhat different perspective is taken. Here, the explicit condition for growth in terms of expanding sales into foreign markets, is claimed to be access to some firm-specific assets, originating in sunk costs in R&D, marketing, etc (Dunning, 1977; Helpman & Krugman, 1985; Markusen, 1995). Also here empirical evidence are ample (Caves, 1996).

One fundamental difference between the two models originate in their different assumptions as regards the settings in which firms operate. In the endogenous sunk cost model, a closed economy type of world is implicitly assumed to exist. Hence, entry can only occur through incumbent firms. Furthermore, the way these models are designed, i.e. different forms of oligopoly markets in a closed economy, make entry less probable. The internationalization model embark from an entirely different view of the world. Also in this case are markets characterized by imperfect competition, however, firms grow by entering foreign markets. And to carry the additional costs of serving foreign markets, either through foreign direct investments or through exports, firms incur sunk costs in R&D and marketing which is used to differentiate their goods from those of their competitors, thereby allowing a higher mark-up on prices. The models have in common that they assume that sunk costs can indeed shift the demand curve for the firm's product.

The purpose of this chapter is to examine which one of these seemingly opposing hypotheses that can be empirically supported. To achieve this end, we will implement firm data for a narrowly defined industry (engineering). Hence, we will consider a market structure that is somewhat wider then the strict oligopoly case. In the first part of the analysis we will examine whether firm size constitutes a critical factor in explaining the relative level of firms' sunk costs. Firms defined as large today have a growth process behind them.[40] If sunk costs are endogenous, i.e. if they increase in

[40] In essence, we are assuming that similar firms should react similarly to external shocks, as an enlargement of the market (cf Dixit, 1989).

proportion to the size of the market, we would expect sunk costs to be of approximately the same relative magnitude, e.g., in relation to sales, irrespective of the firm's size. On the other hand, if the relative level of sunk costs differ across firms of different size, that tend to cast some doubts on the endogenous sunk cost hypothesis.[41]

Second, we will investigate how sunk costs, when we control for the size of the firms, influence entry into foreign markets. Such entry, or internationalization, can take different forms depending on economies of scale (at the firm or plant level), the level of trade costs, and the risk of being exposed to "opportunistic" behavior (Hymer, 1960; Williamson, 1975; Brainard, 1993). Here we will only consider internationalization defined in terms of export-intensity, while controlling for the effect of previously established foreign affiliates. If sunk costs has a positive effect on entry on foreign markets through exports, then taking that into account, the market structure in foreign markets will also change.

There are of course numerous factors that interact to determine the export performance by firms. Most prevalent among those are changes in relative prices. However, since we are focusing on a cross-examination of Swedish firms belonging to the same industry, this restriction should not be a cause of great concern since relative price changes vis-à-vis the world is likely to affect the included firms symmetrically. We also disregard factors like supplier structures, strategic considerations, etc., that may motivate firms to entry foreign markets.

The empirical analysis will be based on a firm data set for the year 1990 covering 137 Swedish firms in the engineering industry. In order to grasp the interrelations between sunk costs in firm-specific assets, size and internationalization, it is necessary to pin down the analysis to the sub-industry level. The data-set contain unique information on a stock variable representing accumulated sunk costs in firm-specific assets. In contrast to traditional stock measures, normally restricted to capitalized values of former R&D-expenditure, the extended definition applied here also incorporate investments in marketing and education. Both ordinary least square regression techniques, and methods allowing for a censored dependent variable, will be

[41] That the level of sunk ousts is smaller in smaller firms have found some support in for instance studies by Cabral (1995) and Gilbert (1989),claiming that this reduces the eventual costs of failed entry. Mansfield (1962), Dunne, Roberts & Samuelson (1989) and Mata (1994), conclude that a negative relation exists between firm growth and firm size, i.e. rejecting Gibrat's Law.

implemented. In the latter regressions, some of the estimations have been undertaken in the form of a recursive system. A censored dependent variable estimation technique implies that problems of selection bias can be avoided in the estimations of internationalization, where the dependent variable frequently takes on a value of zero.

This chapter is organized in the following way. Section 4.2 presents the data, the econometric models, and the hypotheses to be tested. The following section 4.3, contains the results of the econometric analysis. Finally, the main results are summarized and discussed in section 4.4.

4.2 Data, econometric specification and hypotheses

4.2.1 The data

The data were collected directly from a random sample of Swedish firms in the engineering sector through surveys and interviews for the year 1990. The selection procedure was performed by Sweden Statistics.[42] The data-set contains detailed information on sales, costs, skill-structure, investments, assets, and foreign production capacity. Mergers, other forms of exit, and altered production, meant that the original sample of 150 firms shrank to 137 firms. The size distribution of the sample is illustrated in Table 1.

The key variable used in the analysis below is the firms' level of sunk costs in firm-specific assets, defined as a stock variable. In most empirical work, the conventional way is to aggregate R&D-expenditures into a stock concept. Different studies use different techniques, apply different depreciation and deflating techniques, implying that a considerable element of arbitrariness is being inserted into these models. We have therefore chosen to use a different method. Our approach has been to ask the firms to provide an estimated value of their firm-specific assets. In contrast to most other studies, the present study derives sunk costs not only from investments in R&D, but

[42] The selection procedure was restricted in the following way: Firms having less than 20 employees was excluded on the basis that they would have negligible sunk costs in firm-specific assets as defined above. In addition, the size segments < 100 employees, 100-500 employees, and > 500 employees, should all contain at least 30 firms each (i.e., 20 percent). A somewhat finer classification level is used in Table 4.1. The questionnaire is available on request.

also in marketing and education. This should give a more accurate estimate of sunk costs, since R&D is just one component of such costs. This variable is operationalized by accumulating expenses on the current cost account, where costs associated with short-run effects (less than one year) are excluded and all values are after depreciation and at reproduction costs.[43]

4.2.2 Econometric specification

The models will first be described, and thereafter the exogenous variables will be defined in detail in section 4.2.3. Two different econometric techniques will be applied, and we will consider each of them separately.

Sunk costs and firm size

In the first model (Model I), the dependent variable is the firm's level of sunk costs in firm-specific assets (FSA), as defined above, per employee. We focus on the impact of firm size (SIZE) on the level of sunk costs, while controlling for other independent variables, contained in the vector X in equation 4.1,

$$FSA_i = c_i + \alpha_1 SIZE_i + X'_i\alpha_2 + \epsilon_i, \tag{4.1}$$

where the subscript i refers to the individual firm. The error term is expected to exhibit standard properties, $\epsilon \sim N(0,\sigma^2)$, and $E(\epsilon_i\epsilon_j)=0$ for $i \neq j$. The regressions will be undertaken by implementing OLS techniques.

Foreign entry, sunk costs, and firm size

The proceeding step in the econometric analysis (Model II) aims at estimating the impact of sunk costs in firm-specific assets on entry into foreign markets through

[44] Of course, also this method can be claimed to be arbitrary and it is doubtlessly based on a subjective evaluation. However, the values are at least based on estimates coming directly from the firms, i.e. those who should be best at evaluating these values. I our view, this method is superior to the one suggested by for example Lambson&Jensen (1998), using gross book value of property, plant and equipment. Each value used in the current analysis has been thoroughly checked in interviews with each of the 137 firms. The question was formulated in the following way: "Please quantify the firms accumulated assets in R&D, marketing and education, either by giving the value directly in Swedish krona, or as percent of fixed assets. Values should be calculated as accumulated investments in above categories, after depreciation and in repurchase prices."

exports. The dependent variable (EXP/TS) is defined as firm i's export from the home country, divided by total sales. Since the dependent variable contains a large number of zeroes (23 percent), we will implement a censored dependent variable technique in this part of the analysis. If all observations where $(EXP/TS)_i=0$ were disregarded, then, irrespective of whether the error term in the population has a zero mean and a constant variance, the sample error will not have these properties because observations have been systematically, rather than randomly, excluded. An appropriate statistical technique in this case is the Tobit method (Tobit 1958),

$$\frac{EXP_i^*}{TS_i} = \gamma_0 + \gamma_1 FSA*_i + Z'\gamma_2 + v_i \,. \tag{4.2}$$

$$\frac{EXP_i}{TS_i} = \begin{cases} \dfrac{EXP_i^*}{TS_i} & if \; \dfrac{EXP_i^*}{TS_i} > 0 \\ 0 & if \; \dfrac{EXP_i^*}{TS_i} \leq 0 \end{cases} \,. \tag{4.3}$$

Since sunk costs in firm-specific assets - which appeared as the endogenous variable in equation 4.1 - is implemented as an explanatory variable with regard to foreign entry through exports, FSA may be correlated with the error term in the Tobit equation (v_i). In that case also ϵ_i and v_i correlated. To take account of this potential source of biasedness, we proceed by estimating Model II as a recursive system. Then the standard properties can be assumed to prevail, i.e., $v \sim N(0, \sigma_v^2)$, $E(v_j v_i)=0$ for $i \neq j$.

Hence, estimating Model II implies that in the first step OLS-technique is applied and we regress all the exogenous variables in the system on sunk costs in FSA, to obtain a predicted value of sunk costs in firm-specific assets (FSA*). Then, in the second step, the actual value of sunk costs in FSA is replaced by the predicted value in the Tobit equations 4.2 and 4.3, which is estimated via maximum likelihood procedures. The implemented control variables are contained in the vector Z. We will also present the results from some additional regressions runs where alternative proxies for sunk costs have been inserted directly into the Tobit function.

4.2.3 Hypotheses

Initially we consider the exogenous variables contained in the vector X in equation 4.1, where the firms' endowment of firm-specific assets per employee, i.e. their relative sunk cost, is the dependent variable. Thereafter we define the variables invoked in explaining firms internationalization. The definitions and expected signs of the explanatory variables are summarized in Table 4.2.[44]

Sunk costs and firm size: the hypotheses

The first run of regression concerns the relationship between the level of sunk costs and the size of the firm. More precisely, we will test whether the coefficient of firm size can be significantly distinguished from zero as we regress size on sunk costs in firm-specific assets per employee.

As regards the size variable, it is not self-evident which measure to use. The accuracy of traditional size variables, like the numbers of employees or assets, have become less apparent due to the emergence of new modes of organizing production. Networks, informal contracts, etc., tend to make the boundaries of the firm less distinct. Similarly, the asset side in the balance sheet is affected by novelties in the way investments are financed. For instance, if firms prefer to lease a large part of their equipments and housing, such assets will never show up in the balance sheet. However, the correlation between the different size measures we have (total turnover, total assets, and employment) is extremely high in our sample (all of the correlation coefficient exceeds .98), and we have chosen to implement the number of employees (L) as our size measure.

The control variables, contained in vector X, used in Model I are the skill composition of the labor force, profits, productivity, production capacity abroad, and the firms production technology. Profitability (PROF) is included since supranormal profit should be positively connected with the possession of some unique asset or knowledge (see Caves, 1996). A weakness is that we do not know whether a high

[44] The correlation between the implemented variables is presented in the appendix.

current profitability also captures how sustainable profits are over time, which would be the preferable variable. Profitability is measured as the relative rate of return, i.e. operating profits before financial costs, depreciation and taxes, divided by total assets.

In the international business literature it is often argued that foreign affiliate production enable a firm to "tap" the host region of its specific and localized knowledge content (Zander, 1995). We have therefore added a variable that captures the respective firm's share of foreign production capacity in relation to its domestic production capacity, measured as the distribution of fixed assets between foreign and domestic production units (FUT). Hence, a higher share of foreign production is expected to contribute positively to a firm's relative level of sunk costs.

We control for the capital intensity, or production technology, by inserting a variable defined as fixed assets per employee (CAP). High capital-intensity (CAP) is assumed to reflect more process, or raw material based production within the engineering industry, where firm-specific assets, as defined above, plays a less important role and hence a negative connection vis-à-vis firm-specific assets is hypothesized. We also include labor productivity (PROD), which is assumed to capture the quality and efficiency of labor, organizational skills, etc., after having controlled for the firm's capital-intensity. We expect a high labor productivity to be positively connected to the level of sunk costs in firm-specific assets.[45]

The skill-structure of firms' employees (S) is - for obvious reasons - also implemented as an explanatory into the regressions. The data-set contains information on the skill of employees divided into five different categories, based on the employees position within the firms, not their formal education. The skill variable is defined as the share of the two most skilled categories out of total employees in the Swedish units, and a positive impact on the dependent variable is expected.

Finally, in order to investigate whether a non-linear relationship prevails between firm-specific assets and size, we have included a quadrativ size variable(QuadL). We have no a priori assumption about the sign of this variable. However, a negative sign implies that the influence of size on firms' endowments of firm-specific assets is

[45] Jovanovic (1982) introduce a positive connection between productivity (efficiency) and the value of the firm, while other studies claim that sunk costs translate into higher firm value (Lambson and Jensen, 1998), suggesting an indirect link between sunk costs in firm-specific assets and productivity.

diminishing, while a positive sign implies that larger firms exert a stronger impact on the accumulation of firm-specific assets.

Foreign entry, sunk costs, and firm size: the hypotheses

Turning to firms' internationalization, the analysis focusses on the influence of sunk costs in firm-specific assets (FSA*) on entry into foreign markets through exports. Particularly, the objective is to examine whether the coefficient of sunk costs can be significantly distinguished from zero as we estimate the determinants of firms' foreign entry, controlling for size. A maintained assumption is that firms operate on markets characterized by imperfect competition, where firm-specific assets is assumed necessary in order for firms to differentiate their goods from close substitutes. The alternative hypothesis is hence that sunk costs in FSA*, as defined above, have a positive effect on the firm's export-intensity.[46]

The following control variables, all contained in the vector Z, are implemented in the regressions. Since firm-specific assets may also promote foreign entry through investments in other countries, we will control for the effect of foreign production capacity (FUT) on the firm's export-intensity.[47] Production units abroad may influence the export-intensity of firms in two conceivable ways. First, it can increase exports through a deeper integration across production units located in different countries. Consequently, in this case the probability of a firm having export should increase if it has foreign subsidiaries. Second, it can also be argued that foreign affiliates replace production in domestic units, implying a negative link between exports from the Swedish based plants and foreign production (Svensson, 1996). It is therefore difficult to a priori assign the effect of foreign production capacity on the export-intensity of firms.

For a small open economy with a limited domestic market, we expect a positive impact of firm size (SIZE) on the firm's exports.[48] For a similar reason, we conjecture

[46] Support for this is also provided by Teece (1982), and Ollinger, Fernandez & Cornejo (1998).

[47] See also Caves (1971), Swedenborg (1979), Dunning (1980), Lall (1980), Hirsch & Biaouhi (1985), Hughes (1985), Greenhalg (1991), and Kravis & Lipsey (1992). These studies embrace exports as well as foreign direct investment.

[48] A strong positive relationship of size on exports is found in most studies. For an overview, see Miesenbock (1989).

that higher capital-intensity in production (CAP), reflecting process- and raw material intensive production, will augment exports. The production volumes required to exploit economies of scale on the plant level can only be attained through exports.[49] Finally, labor productivity (PROD), defined as above, is supposed to enhance the competitiveness of the firm and to positively influence the firms' export-intensity.

In two separate estimations, we have included proxies for sunk costs in firm-specific assets directly into the Tobit function. The first proxy, i.e. the skill composition of the firms' employees (S), was defined as exogenous in Model I, which means that we do not have take into consideration eventual endogenic problems, and can estimate the Tobit function directly. We also implement the sum of current expenditures on R&D and marketing per employee, denoted SPEC, as an alternative proxy. The aim is to examine whether a flow variable yields results that differs from the stock value of FSA, and to what extent these proxies support the findings of the first estimation using stock values.

4.3 Results

Starting with the relation between sunk costs in firm-specific assets and size, the results are shown in Table 4.3. In the first estimation (Model Ia), the size variable has the expected sign but fails to attain significance. Among the control variables, the skill structure of employees is shown to have the strongest influence on the firm's level of sunk costs. Also profitability has a positive impact on FSA, albeit much weaker. The other control variables, that is, productivity, capital-intensity, and foreign production capacity, all fail to attain statistical significance. As shown in Model Ib, the overall explanatory power of the regression is substantially reduced if we omit the variable capturing the skill composition of firms. Moreover, size then appears to have a weak positive influence on FSA, while profitability become negative and insignificant. Instead labor productivity is shown to have a significantly positive effect on the dependent variable, probably due to that some of the effects contained in the omitted skill variable is then captured by the productivity variable. Moreover, capital-intensive

[49] In the theoretical literature scale economies on the firm level favors foreign direct investment (FDI), while scale effects on the plant level is more likely to promote exports. Important in this context is the interaction between economies of scale and trade costs (see Brainard, 1993).

production technologies seem to exert a negative impact on the accumulation of FSA.

The insignificance of size in the first regression (Model Ia), may be due to a non-linear relationship between size and the firm's endowment of firm-specific assets. It could be that firms of different size are inherently different. In the following estimation (Model Ic), we have therefore included a quadratic size variable to capture the presence of a non-linear relationship. As revealed in the estimation of Model Ic, the introduction of the quadratic variable has a substantial effect on the results. First, the size variable turns significant on the 5-percent level, implying that FSA is indeed increasing in size. However, as shown by the negative quadratic size variable, also significant at the 5-percent level, the impact of size is decreasing. The parameter value, being much smaller than for the size variable, implies that the decreasing effect is relatively limited. Hence, there seems to be a concave relationship between the size of the firm and the firm's endowment of FSA. This can be interpreted as if the often asserted ability of firms to handle knowledge is limited, i.e., the firm can only handle knowledge efficiently up to a given level. The inclusion of the quadratic size variable had little effect on the remaining control variables, as compared to estimation of Model Ia. Hence, firms serving a larger market will increase their relative outlays on sunk costs, however, at a decreasing rate.

To summarize, the results of the first regression (Model I) suggest that size - together with the skill structure - has a positive but diminishing impact on firms' relative endowments of sunk costs in FSA.[50] Hence, the coefficient of size is significantly separated from zero and we can reject the null hypothesis.

Turning to the firms degree of internationalization, Table 4.4 pictures the result of the Tobit estimations (i.e., the second step of Model II) of the impact of sunk costs in firm-specific assets (FSA*) per employee on entry through exports. The Tobit equations are first estimated as a recursive system. Controlling for the effect of firm size, the strongest support is found for the FSA*-variable, which is significant at the one-percent level (Model Iia). Both the variables capturing size and capital-intensive production technologies are found to have a (weak) positive impact on export-intensity. Furthermore, productivity has the expected positive impact and is significant, while the

[50] A Houseman test confirms that causality goes from the skill-structure of employees to firm-specific assets, not the other way.

influence of profits contradicts our expectations, being significant and negative. The prevalence of foreign affiliate production capacity is negatively related to export-intensity, but fails to attain significance. Taken together, the results suggest that sunk costs in firm-specific assets has a strong and dominant effect on entry by firms on foreign markets through exports.

In the following two estimations (Model IIb and IIc), sunk costs in FSA* have been replaced by current expenditure on R&D and marketing (SPEC) per employee, and the skill structure of the firms' employees (S), respectively. These variables have been inserted directly into the Tobit equation. The remaining control variables are identical to those in the first Tobit estimation. As can be seen in Table 4.4, both of these variables also attain significance in the Tobit estimations, implying that impact of sunk costs on entry through exports seems robust. However, much of the significance of the control variables vanish or is diminished. Furthermore, the coefficients for the proxies of sunk costs in FSA are also considerably lower. We therefore conclude that the stock measure seems to be the preferable proxy for sunk costs in firm-specific assets.

To conclude, the estimations provide evidence that the coefficient of sunk costs in firm-specific assets is significantly distinguished from zero, and also in this case we can reject the null hypothesis. Rather, sunk costs in firm-specific assets seems to be a means for the firm to grow by entering foreign markets, thereby expanding their sales.

4.4 Concluding remarks

In this paper we have attempted to shed light on the relation between sunk costs in firms-specific assets (FSA) and firm (market) size on the one hand, and sunk costs in FSA and entry on foreign markets through exports on the other hand. We have done that by confronting two hypotheses in the industrial organization literature that to some extent seem to contradict each other. Do firms expand their investments in sunk costs in proportion to an expansion of the market, or does the market expand for firms that incur higher expenditures on sunk costs? If the former was true, then we would expect firms of different size - i.e. irrespective of the size of the market they serve - to have approximately the same relative expenditure levels for sunk costs, e.g., per employee. On the other hand, if firms manage to shift the foreign demand curve for their products as they increase the level of sunk costs, then the latter effect seems more likely to prevail. The two hypotheses need not be completely discriminating, for instance, we can think of firms of the same size, but located in different countries, that increase their level of sunk costs due to an opening up of new markets.[51] However, this is a somewhat different issue then the question purported in the present paper.

We hence conclude that the endogeniety hypothesis of sunk costs fail to attain support, at least when we extend the analysis to embrace market structures characterized by more then just a few firms, that is, when we leave the "pure"oligopoly world. The level of sunk costs is larger in absolute and relative terms in more sizeable firms. Furthermore, the demising impact of size on firms' endowment of FSA suggest that when we abandon the close world economy and consider the world market, an endogenous relationship between suck costs and market size becomes even less likely.

Notwithstanding that firm growth can be expected to result from both market growth and the strategic decisions taken by a firm, our results indicate that the firm's own explicit decisions to increase its outlays on FSA is a crucial ingredient of growth, rather then a passive adjustment to an increase in market size. Particularly since it seems to enable expansion on foreign markets. Entry on foreign markets, either through exports or by setting up foreign affiliates, also means that the local market structure will be affected.

[51] For a life cycle explanation of entry and exits, see Klepper & Graddy (1990) and Jovanovic & McDonald (1994). Mata (1993) conclude that sectors with higher turbulence rates - which could be correlated with size - also have lower sunk cost.

Table 4.1. The size distribution of firms in the sample

Size (numbers of employees)	**Share of firms, percentage**
< 100	38.4
100 - 200	21
200 - 500	18
> 500	22.6
Total	100

Table 4.2. Definitions and expected signs of explanatory variables

Exogenous variables, firm level data	*Definitions*	*Expected sign*
Sunk costs in firm-specific assets.	FSA, accumulated stock of investments in R&D, marketing and education per employee.	+
Size.	L, total domestic employment.	+
Quadratic size	QuadL, quadratic value of L	?
Skill structure of employees.	S, the percentage share of the two most qualified categories of employees.	+
Profitability.	PROF, rate of return on total capital.	+
Productivity.	PROD, value-added per employee.	+
Capital-intensity.	CAP, fixed assets per employee.	+/-
R&D and marketing outlays.	SPEC, current expenditure on R&D and marketing per employee.	+
Production abroad.	FUT, percentage of fixed assets abroad.	?

Table 4.3. Sunk costs in firm-specific assets and size (1990)

Method = OLS	MODEL I (Dependent variable = firm-specific assets/employee)		
Dependent variables	Model Ia	Model Ib	Model Ic
INTERCEPT	.004 (.14)	-4.63*** (-10.17)	.003 (.10)
L	2.1E-7 (.76)	7.0 E-6* (1.82)	1.7 E-6** (2.21)
PROF	.17* (1.66)	-1.56 (-1.09)	.16 (1.58)
PROD	-.18 (1.21)	6.69*** (3.41)	-.17 (-1.12)
CAP	.003 (.08)	-1.30*** (-2.67)	-.003 (-.09)
FUT	-7.3 E-7 (-.11)	-.001 (-.68)	-7.1 E-6 (-.96)
S	.37*** (5.69)	--	.34*** (5.12)
QuadL			-3.1 E-10** (-2.07)
F-value	7.81	4.17	7.47
Adj. R^2	.23	.11	.25
No of Observations	134	134	134

Note: ***, ** and * indicate significance at 1, 5 and 10 percent respectively, t-values in parenthesis.

Table 4.4. Internationalization, sunk costs in firms-specific assets, and size (1990)

Method = Tobit	Dependent variable = EXP/TS		
Independent variables	Model IIa (recursive system)	Model IIb	Model IIc
INTERCEPT	-.13* (-.08)	-.04 (.08)	-.13* (.08)
*FSA**	2.29*** (.39)		
SPEC		1.70*** (.39)	
S			.77*** (.16)
L	1.15 E-5 * (7.17 E-6)	1.81 E-5** (7.34 E-6)	2.02 E-5*** (7.10 E-6)
PROD	.57* (.32)	.51 (.35)	.30 (.36)
CAP	.12* (.07)	.06 (.08)	.11 (.08)
PROF	-.58** (.27)	-.32 (.29)	-.23 (.29)
FUT	-1.21 E-4 (1.58 E-3)	-1.93 E-4 (1.66 E-4)	-1.97 E-4 (1.62 E-4)
Log lik.hood	20.26	25.11	25.83
No. of observations	134	134	137
Left censored variables	26	26	26

Note: Standard errors in parentheses. ***, ** and * indicate significance at 1, 5 and 10 percent respectively.

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Appendix

Table A.1. Correlation Matrix

	FSA	S	SIZE	PROF	PROD	FUT	CAP	QUADL
FSA	1							
S	.50	1						
Size	.14	.14	1					
PROF	.17	.16	.0003	1				
PROD	.17	.42	.06	.53	1			
FUT	.07	.07	.75	-.01	.10	1		
CAP	-.17	-.21	-.05	-.18	.13	-.04	1	
QUADL	.06	.05	.95	-.02	.02	.64	-.03	1

CHAPTER 5

5. Industry clusters in Ohio and Sweden 1975-1995[52]

5.1 Introduction

For several years now, a group of Swedish researchers have investigated the role of 'technological systems' in economic growth (Carlsson, 1995, 1997; Braunerhjelm & Carlsson, 1998a,b; Carlsson & Braunerhjelm, 1998). Technological systems refer to networks of agents in any given field of techno-industrial activity, interacting within a particular institutional infrastructure, to generate, diffuse, and utilize technology (Carlsson & Stankiewicz, 1991). Thus, a technological system is a form of cluster of economic activity, closely related to Erik Dahmén's concept of development blocs (Dahmén, 1950 and 1989), and similar in many ways to the type of clusters studied by Michael Porter in his Competitive Advantage of Nations (1990). The technological system's framework includes not only market interaction among firms but also non-market interaction (especially in the form of knowledge spillovers) among firms and between firms on the one hand and various components of the infrastructure (e.g., academic institutions, research institutes, financial institutions, government agencies, and industry associations) on the other.

A common feature in various approaches to cluster analysis is the ad hoc nature of selecting economic activity for study. But what if it is not clear a priori what economic activities are clustered together? There may be forward and backward linkages, and formal as well as informal networks, which may not be easily identifiable by simply observing existing data, but whose nature may be an important determinant of economic development of a region. The input-output links between, say, the steel industry and the downstream metalworking industries are well-known, but the same is not true for the interaction between manufacturing industries and service industries, especially in the

[52] This Chapter is written together with Professor Bo Carlsson. A version is forthcoming in the Small Business Economics.

area of business services. The relationships between new firms in emerging sectors and existing (older and larger) firms in traditional industries are of particular interest in a dynamic perspective.

The purpose of the present chapter is twofold. The first is to propose a systematic method of identifying clusters of economic activity. The basic idea is to identify industry clusters in a country or region, based on generally available industry data, through the use of a common methodology which does not start from a priori notions of geographic or technology clusters. Second, we will apply the chosen methodology to the analysis of two regions of approximately the same size and industrial structure to see whether the results are in line with expectations. Possible avenues to further refinement of the proposed methodology will also be elaborated.[53] By relating the results of the analysis to the macroeconomic performance over the last 20 years for these regions, we will argue that the outcome on the macro level is influenced by the dynamics of these regions' technological systems.

The two regions we will focus on are the state of Ohio and the country of Sweden, which exhibit a number of similarities and differences. They are similar in terms of population size (10.8 million in Ohio vs. 8.7 million in Sweden in 1993), overall level of development (GAP/capita in 1993 of $23,300 vs. $16,800) and industrial structure (21.5 % vs. 18.3% of the total labor force in manufacturing in 1993). However, there are also distinct differences in terms of economic policy and industrial development in recent years. Economic policies, of course, define the rules of the game and thereby define the framework in which technological systems operate. For example, regulation of the labor market may affect small firms more than large, and taxation policies and the financial system may favor certain firms (e.g., existing firms as distinct from new ones) and industries, thus influencing the industry composition and structure (Johansson 1991a).

The chapter is organized as follows. We begin in the next section with a literature survey of analyses of industry clusters. This is followed by an overview of the present industrial structure in Ohio and Sweden and overall changes since 1975. We then

[53] The method proposed in this study is one of several ways to identify clusters. Other methods include use of patent citations and bibliometric data as well as use of various directories. Such methods will be explored in subsequent work.

present a methodology for identifying industry clusters. This methodology is used to identify the main clusters of economic activity in Ohio and Sweden and their evolution over the last twenty years. The final section presents our conclusions and raises some issues for further research.

5.2 The clustering of economic activities: previous research

In the theoretical literature, two main explanations of agglomeration in clusters can be discerned. The first explanation builds on supply and demand linkages, where market proximity is viewed as facilitating access to suppliers and customers. Second, the possibility of reaping spillovers which are "sticky" in nature (in the sense that they adhere to a particular location) fosters spatial concentration. This seems to be particularly relevant for knowledge, or R&D-intensive, firms. Hence, the literature has singled out two criteria as particularly important in defining clusters: economic activities should be spatially concentrated, and there should be a certain degree of interaction among economic agents. Whenever such agglomeration economies exist, they have a tendency to become reinforced over time. If firms locate where markets are large, this will further increase market size and attract other firms, and as Myrdal (1957) puts it, initiate a pattern of "cumulative causation".

Demand and supply linkages

Agglomeration effects were first explicitly defined in Alfred Weber's (1909) seminal work in locational economics. Weber distinguished between three different categories of determinants in location of manufacturing production: transport costs, labor, and agglomeration. The first two factors have to do with the technology of firms (labor- or raw material-intensive) and distance to markets. The third is linked to the exploitation of agglomeration economies, which, according to Weber, are defined as "...an 'advantage' or a cheapening of production or marketing which results from the fact that production is carried on to some considerable extent at one place ..." (Weber, 1929, p. 126). More precisely, these advantages are divided into three categories: First, they can accrue from economies of scale related to the firm's production. Second, clustering may occur because of proximity to suppliers, a pooled labor market, or localized diffusion of knowledge. Finally, concentration in production may give rise to external advantages such as a highly developed infrastructure, low costs of energy, etc., - i.e., what Weber refers to as urbanization economies.

The reasons for agglomeration are, in Weber's view, based on a cost-minimization decision by the firms. Thus, firms would agglomerate into one spot only if the savings surpassed the costs. In other words, agglomeration was modeled as a trade-off between agglomeration economies and transport costs (compare Krugman, 1991).[54] Overall, however, locational economics became overshadowed by the dominance of the general equilibrium paradigm, which was based on markets characterized by perfect competition and no or negligible transport costs. It was not until the early 1990s, when Krugman (1991, 1995) picked up the thread from Marshall, Weber, and Myrdal, et al., and incorporated locational issues into the general equilibrium model, that a new wave of research, based on interaction between cost of market access and costs of production, was initiated in this field of economics (see Brainard, 1993; Markusen, 1995; Venables, 1995).

Localized spillovers

As noted above, the importance of spillover has long been recognized as an important locational factor. During the last decade it has received renewed interest - much due to Romer's (1986) contribution to the theory of economic growth.[55] Romer's main point is that knowledge is the prime engine behind growth. Since knowledge is an intangible asset predominantly kept and carried by human beings, it cannot be fully appropriated by firms.[56] Knowledge spillovers tend to increase the locational attractiveness of regions. Stickiness, and international mobility of production, within as well as between countries and regions, will hence influence the macro-level of the economy (Braunerhjelm, 1994). Building on Romer's finding, there is an obvious link between

[54] The work by Weber was further developed by Christaller (1933), Lösch (1940), Isard (1956) and Myrdal (1957). The most influential theoretical work in this field in the 1920s was perhaps Hotelling's (1929) spatial model.

[55] See also Grossman-Helpman (1991).

[56] According to von Hippel (1987), the main diffusion of knowledge occurs through people in their daily communication. This relates the difference between communication and information, where the former requires explicit interaction between individuals, due to elements of complexity and tacitness.

location, spillovers and macroeconomic performance.

Several studies have verified that knowledge is to a large extent localized, i.e., it is dependent on regional competencies and technological infrastructures (Malecki, 1981, 1985; Thomas, 1985; Sweeny, 1987; Lundvall, 1992). One piece of evidence emanates from the studies showing the importance of networks of firms as an important source of new knowledge (Dahmén, 1950; Stohr, 1986; Jaffe, 1989; Storper & Walker, 1989; Acs, Audretsch & Feldman, 1992, 1994; Dosi, 1988; Johansson, 1991b; Sayer & Walker, 1993; Antonelli, 1995; Audretsch, 1995; Audretsch and Feldman, 1996a, 1996b; Carlsson, 1997).[57] For instance, Feldman (1994) shows how the rate of innovation is linked to specific geographic clusters of R&D, a line which is also pursued in Saxenian's (1994) work on "local industrial systems". Based on an empirical study embracing several countries, Markusen (1996) provides a detailed account of the heterogeneity that characterizes various industrial districts and their potential for future growth.[58]

Most empirical work has focused on the manufacturing sector (e.g. Markusen et al., 1986; Goodman et al., 1989; Krugman, 1991; Pyke and Sengenberger, 1992; Ellison and Glaeser, 1994). A number of country studies has also been undertaken, many of them influenced by Porter's work on competitive advantage across nations. There is a similar richness when it comes to the methodology applied in defining clusters, ranging from trade-based measures and distance matrices to various versions of location quotients, Gini-coefficients, and more ad hoc applied methods[59]. Hence, there seems to be little consensus on the appropriate measure of clusters. One objective of the present paper is to present plausible criteria for identifying clusters.

5.3 Comparison of industry structure in Ohio and Sweden

The industrial structure is quite similar in Ohio and Sweden (see appendix), despite

[57] See also Enright (1994) and Schott (1994). Enright (1994) claims that clusters make it possible for firms to specialize to ha higher extent, since fewer activities have to be internalized within the firm due to mutual independence created within the network.

[58] See also Scott (1988) and Storper (1995).

[59] See for instance Everitt (1993), Karlsson & Olsson (1995) and Peneder (1995).

some obvious differences in the economic policy pursued in the two regions during 1975-1995. We will first try to distinguish the development in the respective region on the 1-digit level, and thereafter move on to a more detailed description on the 2-digit level.

Employment declined in the manufacturing sector (Mfg) in Ohio between 1975 and 1993, but increased generally in the other sectors, particularly services (Serv). Overall, there was a gain of about 1 million jobs over the period as a whole (Figure 5.1). In comparison, the Swedish decline in manufacturing was much more severe. As shown in Figure 5.2, the retail and wholesale trade sectors as well as the construction sector maintained their employment levels, while most service sectors expanded in terms of employment (the transportation, communication, and public utilities (TCPU) sector; finance, insurance and real estate (FIRE), and other Services). The combined result was a growth in total employment of about 1 million between 1975 and 1990, followed by a decline of about 200,000 between 1990 and 1993. The entire net gain in employment over the period as a whole occurred in the service industries (Serv in Figure 2), and in public administration in Sweden. [60]

The overall change in the structure and level of employment in both Ohio and Sweden is shown in Figure 5.3. The Mining, Construction, and Manufacturing sectors together represented about half of Swedish employment in 1975, a much higher percentage than in Ohio where Retail trade and Services represented a much larger fraction. While the employment shifts have generally been in the same direction in both countries, the Retail trade sector has remained much larger and grown much faster in Ohio than in Sweden. On the other hand, Services and Finance, insurance and real estate have grown much faster in Sweden in the last two decades and now represent a greater share of total employment than in Ohio.

A similar comparison can be made of the number and distribution by industry of establishments over time (Figures 5.4 and 5.5). The changes in the distribution are

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[60] It should be noted, however, that "Public Administration" is defined rather narrowly in Sweden, consisting of state and local government, defense, police, and fire-fighting services. The "public sector" is much more broadly defined, but in the data shown here, public employees are not shown separately but are distributed to the various industries in which they are employed (mainly services). For Ohio, by contrast, all government workers are reported as a separate "industry" (Gov). Thus, the distribution of employment by industry is not strictly comparable between the two regions for this reason, particularly with respect to Government and Public Administration.

similar, of course, to those in employment, and yet there are some important differences. The number of establishments in manufacturing stayed roughly constant in Ohio, even though manufacturing employment declined. The number of establishments in the construction industry increased while employment stayed the same. Overall, the number of establishments increased by nearly 100,000 (55%).

In Sweden, the number of establishments increased in all sectors except manufacturing (where it grew slowly until 1990 but then fell back to its 1975 level, while manufacturing employment fell sharply). As a result, the total number of establishments increased by nearly 200,000 (70%). But a significant part of the increase is attributable to improved data coverage in the public sector over the period.[61] The total number of establishments was larger in Sweden in all sectors except Services (dominated by public administration) throughout the period 1975-1993. The greatest differences occurred in Finance, insurance and real estate and Manufacturing.[62] The distribution did not change much in Ohio, while it shifted from Manufacturing and Retail trade to Finance, insurance and real estate and Services in Sweden.

At the 2-digit level, the similarities (and differences) in industry structure between Ohio and Sweden are examined by using so-called location quotients (similar to the concept of revealed comparative advantage in the trade literature). The basic idea is that the composition of industry in both Ohio and Sweden is compared to that of the United States. In the case of Ohio, if a given industry has the same share of Ohio's total employment as Ohio does of total U.S. employment (4.6% in 1995), its location quotient is 1.0. Similarly for a Swedish industry whose share of Swedish employment corresponds to Sweden's 'share' of U.S. employment (3.4%).

From Table 5.1 and Table 5.2 it can be seen that out of the top 10 industries, ranked according to the location quotient, five coincide in the two regions. The differences can be attributed primarily to the service sector, which is more important in Ohio, and the Swedish forest industry which is represented by industries in the Swedish top 10

[61] The statistical coverage of public employment in Sweden was particularly poor in the 1970s but improved dramatically in the 1980s. Thus, the increase in employment in services and public administration is exaggerated in Figures 5.2 and 5.5.

[62] It is possible that a substantial part of the increase in the number of establishments in Financial, insurance, and real estate services (FIRE) and Other services (Serv) is attributable to the creation, mainly for the purpose of tax benefits, of private firms with few or no employees.

ranking (24,26). This is a sector where Sweden has clear comparative advantage (for a detailed comparison of the industrial structure, see the appendix).

5.4 Methodology for selecting clusters

Having briefly surveyed the industrial structure in Ohio and Sweden over the last 20 years by employing conventional industry data, we turn now to a different (and somewhat novel) type of analysis, namely industry clusters. The main idea is that rather than looking at each industry separately, it makes sense to try to understand industrial transformation as a result of broader changes affecting not just individual sectors but whole clusters of industries. How then can one define such industry clusters?

Methodology

The methodology chosen for the present analysis is outlined in this section. It focuses on two key ideas: that linkages are important, and that a certain concentration of activity is required to form a cluster. [63]

1. At this level of regional analysis, it is desirable that the clusters we identify be fairly broadly defined. Therefore, we started with 2-digit SIC industries. Broad industry definitions facilitate identification of important linkages via input-output tables which may be difficult to obtain at lower levels of aggregation. From the pattern that evolves from this level of analysis, future research will narrow down to a few clusters for detailed analysis. We imposed the condition that to be considered the core in a cluster, the industry should have total employment exceeding 10,000, which amounts to approximately one percent of employment in the manufacturing sector for both Ohio and Sweden (1993).

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[63] There are numerous examples of other methods of identifying clusters. For example, DRI/ McGraw-Hill (1995) presents a "Cluster Power Index" which gives 40% weight to industry employment, 40% to "employment concentration" (not specifically defined), 10% to "cluster depth" (not defined), and 10% to employment growth. One of the drawbacks with this weighting scheme is that cities or regions with a diversified economy do not show up in the clusters. An alternative and much more comprehensive methodology (including use of location quotients, shift-share data, and Gini coefficients, as well as a variety of "soft" data) is outlined by Rosenfeld (1995, pp. 67-69). Another approach is suggested by Löfvenholm & Rask (1995). All of them are characterized by an ad hoc approach as concerns the selection of cluster criteria.

2. Each core industry should constitute a significant share of economic activity in the relevant fields. Therefore, for each industry we calculated the "location quotient," i.e. Ohio's and Sweden's share of total U.S. employment in the industry. We imposed the condition that the location quotient at the end of the period studied should be at least 1.3 (i.e., the region should have at least 30 percent more than its 'fair share' of U.S. employment in the industry).

3. Industries which have significant linkages to other industries should be included and others excluded. Thus, we obtained the commodity by commodity total requirement coefficients from the U.S. input/output table for 1987 (2-digit level).[64] We counted the number of both horizontal and vertical coefficients for each industry exceeding certain levels (0.1, 0.15, and 0.2, respectively); each coefficient meeting the requirement was referred to as a 'contact.' The sum of the number of contacts excluding the industry's deliveries to and purchases from itself was computed. The distribution of the number of contacts across industries was found to be similar at all three levels. We chose the 0.15 level and imposed the criterion that the number of contacts should exceed four in order for an industry to be considered the core of a cluster. An industry may fail to meet this criterion either by having fewer 'intense' contacts with other industries or by not having sufficiently close links to at least four other industries.

4. We calculated the total employment in each cluster by adding to each core industry its share of "contact" industry employment as represented by the input-output coefficients. This means that a core industry with few contacts has larger employment in the core than in the cluster, whereas the industries with the most significant contacts have considerably larger cluster employment than core industry employment.

The results of these various steps are shown in Tables 5.3 and 5.4. The industries which meet the respective criteria are marked with an asterisk (*) in the appropriate column. The industries which meet all three criteria are listed in descending order of

[64] The U.S. input/output table for 1987 is the latest one available. Input/output tables for both Ohio and Sweden are currently not available for later years. The U.S. input/output table for 1975 has been used for certain calculations for 1975 as indicated in the text.

total cluster employment, followed by non-qualifying industries (i.e., those meeting fewer than the three criteria) in descending order of cluster employment.

Results

As shown in the tables, six clusters are identified in Ohio and seven in Sweden, representing 21.0 and 32.3 percent of total employment, respectively. According to the selected criteria, the largest clusters in Ohio are Industrial machinery and equipment, followed by Fabricated metal products and Transportation equipment (Table 5.3). All of the identified clusters consist of traditional, 'hard-core' manufacturing activities, reflecting Ohio's long-standing traditions. It turns out that the location quotient criterion is the dominant one in Ohio (as well as in Sweden). However, the location quotient criterion would have to be reduced from 1.3 to 1.0 in order for more industries to qualify, but only one of these (Electronic and other electric equipment) also meets the 'contacts' criterion. The employment criterion would have to be raised above 50,000 and the 'contacts' criterion above 5 to be constraining.

The corresponding results for Sweden are shown in Table 5.4. The seven clusters identified in Sweden contain a mixture of service and manufacturing industries. The largest is Transportation services and the second largest is Communications (i.e., postal and telecommunications services). This result is somewhat surprising; it is due in large measure to high location quotients which, in turn, reflect the inclusion of government workers in these sectors in the Swedish data but not in the U.S. data. Further exploration of this finding is certainly warranted.[65] The other identified clusters are traditional manufacturing industries for which Sweden has long been known: Industrial machinery and equipment; Fabricated metal products; Transportation equipment; Primary metal industries; and Paper and allied products. This list contains no surprises. If the location quotient criterion were lowered to 1.2, one more industry (Construction) would qualify. If the criterion were reduced to 1.1, another four industries would qualify: Electronics & other electric equipment; Real estate, holding and other investment offices; Food and kindred products; and Amusement and recreation services. On the other hand, if the criterion were raised to 1.4, Transportation services would no longer qualify, and

[65] Unfortunately, due to the lack of other data (such as value added) we have not been able to resolve this problem.

Primary metal industries would not qualify if the limit were set at 1.5. Further inspection of Table 4 reveals that the employment criterion would have to be raised above 30,000 and the number of 'contacts' above 10 in order to be constraining. Thus, the list of selected clusters appears to be not only sensible but also fairly robust to alternate assumptions in both regions. It is not really surprising that all of the selected clusters in Ohio and most of those in Sweden are in manufacturing, in spite of the rapid growth in many service industries in recent years. The latter still do not qualify as 'clusters' under the criteria chosen here, in most cases because their location quotients rarely exceed 1.0 (i.e., neither Sweden nor Ohio has a comparative advantage in service industries) but also because their linkages to other industries are relatively weak. Only rarely do they constitute a core which generates other economic activity; more often they provide support for other industries. Perhaps this is inherent in 'service' industries. The most notable non-qualifier here is Business services which has numerous linkages to other industries and therefore has a cluster employment twice as large as the core industry employment. But its location quotient was 0.879 in Ohio in 1995 and only 0.521 i Sweden in 1993, both having increased by about 8 percent since 1975.

It turns out that the four largest manufacturing clusters are exactly the same in Ohio and Sweden. The Industrial machinery and equipment industry constitutes the core of the largest cluster (in terms of total employment) in Ohio and the largest manufacturing cluster in Sweden. Fabricated metal products, Transportation equipment, and Primary metal products are the next largest manufacturing clusters in both regions. The combined employment in these four clusters is 877.200 (19.6% of total employment) in Ohio vs. 479.400 (14,7%) in Sweden. The number of establishments in these clusters is 19,081 (6.8% of the total) in Ohio vs. 31,658 (6.3%) in Sweden.[66]

5.5 Technological systems and economic development in Ohio and Sweden, 1975-1995

In spite of all our efforts to avoid a priori notions of what constitutes major

[66] In addition to the methodology outlined above, we also tried some alternatives in which we took into account changes over time in location quotients as well as the sum of inputs from other industrs.Neither of these materially affected the outcome unless they were assigned extremely large weights.

agglomerations of economic activity, the industry clusters we have come up with for further analysis contain no surprises and are all basically in mature industries. Only if we relax the qualifying criteria do we find evidence of emerging clusters in health, business, and transportation services. This suggests that the path dependence is extremely strong. At least at the surface, i.e., at the relatively high level of aggregation in this study, there is not much indication of industrial transformation taking place in either Ohio or Sweden. Perhaps such a transformation could be identified if we could do the analysis at a lower level of aggregation.[67] Our results also suggest that economic performance is to a large extent coupled to the dynamics of the technological systems, i.e., the refinements and upgrading of mature technologies and their application in novel contexts. At this level of aggregation we can only guess at the relation between performance on the macro level and the development within these technological systems.

The macroeconomic performance in both Ohio and Sweden has been considerably worse than in the United States and the OECD area as a whole since 1975 in terms of GDP growth (Figure 5.6). Ohio kept pace with OECD and the rest of the U.S. until 1979 but then went into a steep decline until 1982. After that, there was stable growth until another recession hit in 1990. In Sweden, GDP stagnated in the late 1970s, grew modestly in the 1980s and then declined sharply in the early 1990s.

If we restrict the analysis to manufacturing alone, we find that output in Ohio declined by 20% 1978-83 and then did not exceed its 1978 level again until the early 1990s. In Sweden, manufacturing output was stagnant 1975-84, then grew steadily until 1989, only to decline again until 1993. The recovery has been strong in both Ohio and Sweden in the last few years.

The picture is somewhat different when it comes to employment growth. See Figure 5.7. Ohio has generally expanded employment more quickly than the OECD area as a whole but not as fast as the United States overall. Sweden tracked the OECD average 1975-85 and then fell below, disastrously so after 1990. It appears as though Sweden is now experiencing a crisis similar to that which Ohio went through ten years earlier.

Employment in manufacturing has declined in most countries over the last two decades, as reflected in the declining OECD average. However, the United States

[67] See the appendix for further discussion of the changes in Ohio and Sweden after 1975.

maintained its manufacturing employment until the early 1990s and then suffered a decline. (But of course, manufacturing employment declined as a share of total employment in the United States, similarly to developments in other countries.) In Ohio, manufacturing employment increased until 1979, then declined sharply until 1983 as a deep crisis hit, and has remained roughly constant subsequently (Regional Financial Associates). In Sweden, manufacturing employment has declined steadily and quite precipitously after 1989.

Herein lies an important explanation for the relatively poor performance of both Ohio and Sweden relative to the United States in terms of employment growth over the last two decades. They either gained shares in declining industries (this is true for Ohio) or lost shares in declining industries (as in Sweden). Ohio also gained shares in such rapidly growing industries as Holding and other investment offices, Social services, Business services, and Transportation services - but not enough to attain a location quotient exceeding 1.0 in 1995. In Sweden, the most rapidly growing industries (in terms of location quotients) were all service industries: Communications, Health, education, and social services, and Electric, gas, and sanitary services (although, as indicated earlier, a significant share of the increases in these sectors may be due to improved statistical coverage in the later part of the period). It indicates that technological systems to a considerable extent have remained in their traditional sectors and that interaction with "novel" sectors so far is quite modest.

5.6 Concluding remarks

Having come up with a methodology for identifying industry clusters, we have reached the first station on a much longer journey. The next stage will be to select a subset of clusters in each country and do a more in-depth analysis and comparison of the specific linkages (in terms of both interaction and spatial concentration) among various entities within each country or region. (We have data for 87 counties in Ohio and 70 regions in Sweden.) Our work on technological systems has shown that while input-output relationships are important, they may not be the most important; 'problem-solving' networks are what really define such systems, not buyer-supplier links. Such relationships can only be identified and analyzed through primary data collection (via interviews, plant visits, etc.) which also needs to be oriented towards analyzing infrastructure and institutional arrangements. Various methods of identifying clusters will be explored and compared in subsequent studies.

The clusters identified for both Ohio and Sweden can be characterized as founded predominantly in traditional manufacturing industries. Our results suggest that the beneficial effects of clusters diminish or even turn negative in the mature phase of the product cycle. This is in support of Audretsch & Feldman's result (1996, partly drawing on Klepper 1996).

And yet, this may be too rash and pessimistic a conclusion. Studies in both Ohio and Sweden indicate that new firms tend to continue to cluster in industries in which the region exhibits traditional strength. For example, recent studies of the aerospace cluster in northeast Ohio (Berry, Johnson & Stavros, 1996) and the biomedical sector in Ohio (Berry, 1996) show that both of these clusters draw heavily upon traditional strength in the machinery industry in Ohio. The aerospace cluster focuses on jet engines and parts, relying on the supporting machinery industries. Similarly, the biomedical activity is closely tied to instruments, measurement equipment, and industrial machinery - also areas of traditional strength in Ohio. Studies by & Rickne & Jacobsson (1996) on new technology-based firms and industrial renewal in Sweden and by Holmén & Jacobsson (1996) on industry clusters in western Sweden also suggest strong path dependence. Clustering is also revealed in the direct foreign investment by knowledge-intensive Swedish firms which tend to locate their foreign operations in regions in which their respective industries are already well represented (Braunerhjelm & Svensson 1996).

Thus, there is reason to suspect that there is much more of a dynamic nature going on than meets the eye at the aggregate level. One of the objects of our investigation will be to examine whether or not the old 'flagship' industries are stagnating or continuing to evolve. What is the role of entrepreneurship in their recent development? What shifts have there been in the size distribution of firms in these clusters, and why? What do the gross and net exit and entry numbers show? Is there renewal taking place and are those renewal processes similar or different in different settings? What role do economic policies and institutional arrangements play? These are some of the questions for further analysis.

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Appendix

Table 5.1 shows the 2-digit SIC industries for which Ohio exhibits the highest location quotients, ranked by the 1995 quotients. The Primary metals industries, Rubber and miscellaneous plastics products, and Fabricated metal products are the largest industries relative to their U.S. counterparts, followed by Stone, clay, and glass products, Transportation equipment, and Industrial machinery and equipment. The ranking of industries according to location quotients was nearly the same in 1975 as in 1995, in spite of the fact that the employment in these industries grew at very different rates. For example, the location quotient of the Primary metals industries increased (by 17.1%), in spite of the fact that 1995 employment in the industry was only 63% of its 1975 level. This indicates that the employment in the Primary metals industry was reduced even more in other parts of the United States. In fact, the Rubber and miscellaneous plastics products industry is the only one among the top six industries in Ohio whose employment grew over the 20-year period. On the other hand, employment increased in Miscellaneous repair services, Personal services, and Health services whose location quotients also increased, i.e., whose share of the U.S. total increased.

Table 5.2 shows the corresponding data for Sweden. Metal mining, Communications, Health, education, and social services, and Paper and allied products are the relatively largest industries in Sweden. But except for Health, education, and social services and Transportation services, all of the relatively largest industries saw their location quotients reduced between 1975 and 1993, contrary to the development in Ohio. But similarly to Ohio, the labor force in these large industries was reduced (again with the exception of the Health, etc., sector, Transportation services, and Construction). Also, the number of establishments increased in most of these industries, in spite of declining employment.

Table 5.1. Ohio Location Quotients 1975 and 1995 (ranked by 1995 location quotients)

SIC	Description	Location quotients 1975	Location quotients 1995	Change in location quotients 1995/75	Employment Ratio 1995/75	Number of Establishments ratio 1995/75
33	Primary metal products	2,363	2,768	1,171	0,63	0,83
30	Rubber & misc. plastics products	2,144	2,272	1,060	1,36	1,78
34	Fabricated metal products	2,157	2,233	1,035	0,87	1,04
32	Stone, clay, and glass products	2,046	1,753	0,857	0,67	0,85
37	Transportation equipment	1,749	1,698	0,971	0,85	1,04
35	Industrial machinery and equipment	1,822	1,692	0,929	0,77	0,94
76	Misc. repair services	1,126	1,265	1,123	1,71	1,33
72	Personal services	1,026	1,255	1,223	1,53	1,30
89	Services, nec.	2,332	1,242	0,533	1,27	0,48
80	Health services	1,013	1,121	1,107	2,07	2,69

Source: Regional Financial Associates.

Table 5.2. Swedish Location Quotients 1975 and 1993 (ranked by 1993 location quotients)

SIC	Description	Location quotients 1975	Location quotients 1993	Change in location quotients 1993/75	Employment Ratio 1993/75	Number of Establishments ratio 1993/75
10	Metal mining	3,585	3,276	0,914	0,466	8,500
48	Communications	n.a.	2,241	n.a.	n.a.	n.a.
80,82-84,	Health, educ. & social services	0,807	2,090	2,590	4,712	3,455
26	Paper and allied products	2,494	2,003	0,803	0,770	1,000
34	Fabricated metal products	1,685	1,616	0,959	0,825	1,284
37	Transportation equipment	1,743	1,521	0,873	0,786	1,237
24	Lumber and wood products	2,851	1,501	0,526	0,555	0,909
33	Primary metal industries	1,733	1,403	0,809	0,443	0,890
35	Industrial machinery and equipment	1,644	1,320	0,803	0,682	1,364
40-47	Transportation services	1,213	1,304	1,076	1,382	1,333
15-17	Construction	1,514	1,266	0,836	1,058	1,227

Sources:
Swedish National Central Bureau of Statistics
U.S. Bureau of the Census, County Business Patterns

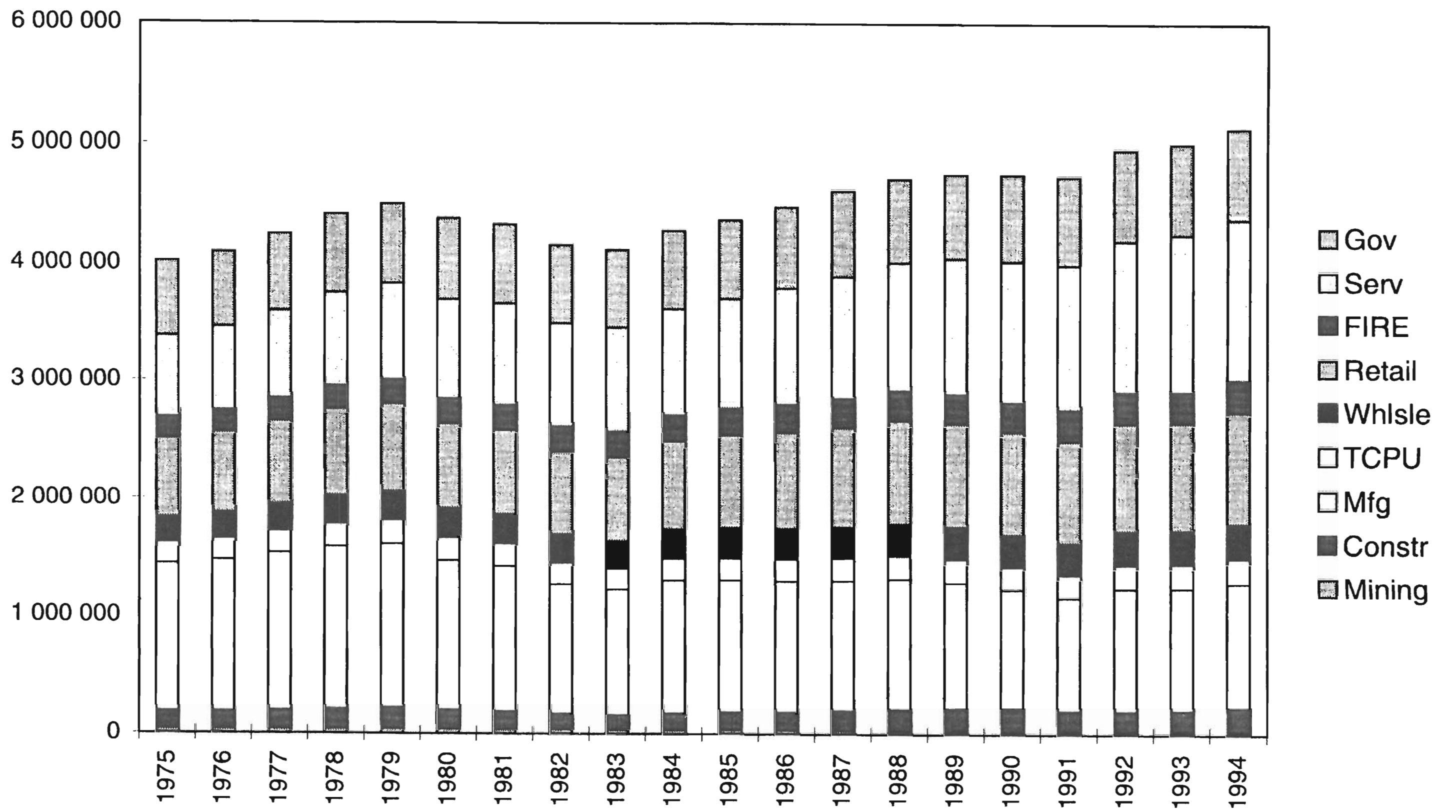
Table 5.3. Ohio Industry Clusters 1995

SIC Code	Core industries	Number of establ. 1995	Employ-ment 1995	Crit.: >10,000	Location quotients 1995	Crit.: >1.3	# of contacts excl. itself	Crit.: >4	Total Cluster Empl.	Total Cluster Establ.	Three criteria met
35	Industrial machinery and equipment	4 449	158 629	*	1,692	*	15	*	326 995	11 082	*
34	Fabricated metal products	2 942	148 277	*	2,233	*	13	*	254 878	6 111	*
37	Transportation equipment	531	138 179	*	1,698	*	11	*	170 916	794	*
33	Primary metal products	668	91 732	*	2,768	*	10	*	124 384	1 094	*
30	Rubber & misc. plastics products	1 388	101 023	*	2,272	*	5	*	35 773	594	*
32	Stone,clay, and glass products	1 005	44 732	*	1,753	*	5	*	25 265	686	*
50-7,59	Wholesale & retail trade	67 460	898 119	*	0,975		13	*	957 483	86 903	
73,87,89	Bus. serv, engin. & mgmt serv, serv, nec	23 601	391 948	*	0,879		20	*	767 283	55 828	
80,82-3,86	Health, educ. & social services	46 460	743 667	*	1,058		1		485 966	19 496	
40-7	Transportation services	8 595	123 273	*	0,708		18	*	247 969	20 891	
36	Electronic & other electric equipment	700	78 953	*	1,060		18	*	197 442	2 115	
15,16,17	Construction	29 100	208 282	*	0,878		7	*	138 667	23 410	
60-4	Financial Services & Insurance	13 276	211 272	*	0,874		5	*	112 885	8 571	
28	Chemicals and allied products	709	45 345	*	0,927		20	*	111 675	2 110	
48	Communications	1 448	47 185	*	0,814		15	*	99 076	3 674	
58	Eating and drinking places	21 590	346 132	*	1,023		2		80 159	6 042	
49	Electricity, gas, and sanitary services	540	46 388	*	0,983		15	*	56 429	794	
70,72,76	Hotels, etc., personal & misc services	13 945	126 325	*	0,867		4		44 757	5 970	
27	Printing and publishing	2 737	77 525	*	1,073		2		39 182	1 672	
65,67	Real Estate, Holding & Oth Invest Off	9 004	64 207	*	0,855		11	*	39 157	6 635	
26	Paper and allied products	419	33 177	*	1,037		10	*	26 317	402	
20	Food and kindred products	721	56 580	*	0,721		4		22 340	344	
79	Amusement & recreation services	3 830	48 579	*	0,781		2		14 593	1 390	
38	Instruments and related products	480	30 040	*	0,764		2		13 371	258	
75	Automotive repair and services	7 633	40 965	*	0,831		2		10 752	2 421	
23	Apparel and other textile products	394	14 273	*	0,327		4		8 848	295	
24	Lumber and wood products	1 145	24 211	*	0,690		2		7 648	437	
39	Miscellaneous manufacturing	711	18 505	*	1,027		1		6 652	309	
25	Furniture and fixtures	418	16 255	*	0,692		0		3 045	95	
13	Crude petroleum and natural gas	548	7 822		0,527		5	*	2 979	252	
22	Textile mill products	90	3 537		0,114		6	*	2 810	86	
29	Petroleum refining and related products	182	5 291		0,768		2		1 835	76	
14	Nonmetallic minerals mining	291	4 846		1,059		0		925	67	
12	Coal mining	120	4 085		0,842		0		770	27	
31	Leather and leather products	43	1 955		0,371		1		446	12	
10	Metal mining	8	191		0,079		1		40	2	
	TOTAL	278 764	4 474 210		1,000				4 474 210	278 764	

Table 5.4. Swedish Industry Clusters 1993

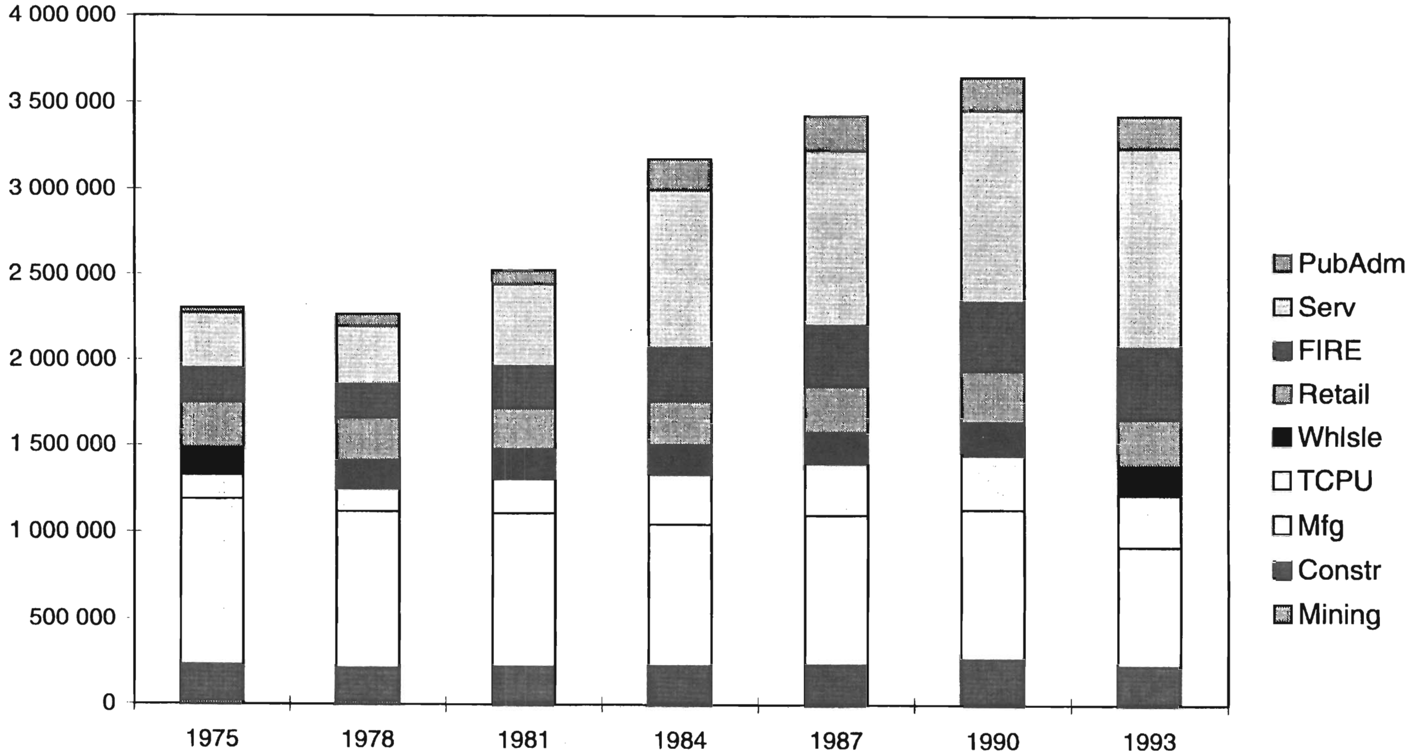
SIC Code	Description	Number of establ. 1993	Employ-ment 1993	Crit.: >10,000	Location quotients 1993	Crit.: >1.3	# of contacts excl. itself	Crit.: >4	Total cluster employ-ment 1993	Total cluster establish-ments 1993	Three criteria met
40-47	Transportation services	35 193	165 955	*	1,304	*	18	*	334 118	72 612	*
48	Communications	3 073	94 967	*	2,241	*	15	*	199 580	6 618	*
35	Industrial machinery and equipment	5 864	90 361	*	1,320	*	15	*	186 432	12 399	*
34	Fabricated metal products	9 302	78 387	*	1,616	*	13	*	134 860	16 401	*
37	Transportation equipment	1 793	90 452	*	1,521	*	11	*	111 980	2 275	*
33	Primary metal industries	419	33 953	*	1,403	*	10	*	46 079	583	*
26	Paper and allied products	427	46 789	*	2,003	*	10	*	37 147	347	*
80,82-3,86	Health, educ., social serv., memb. org.	63 667	1 064 046	*	2,072	*	1		695 934	22 678	
50-57,59	Wholesale & retail trade	125 669	445 227	*	0,662		13	*	475 071	137 420	
73,87,89	Business, engineering serv., services nec	62 888	169 525	*	0,521		20	*	332 155	126 275	
36	Electronic & other electric equipment	2 235	60 133	*	1,106		18	*	150 510	5 733	
15-17	Construction	50 201	219 237	*	1,266		7	*	146 088	34 281	
28	Chemicals and allied products	954	38 170	*	1,069		20	*	94 087	2 410	
60-4	Financial serv. & insurance	7 712	107 779	*	0,610		5	*	57 638	4 227	
65,67	Real Est., Holding and Other Investment Offices	35 795	65 288	*	1,191		11	*	39 852	22 391	
49	Electric, gas, and sanitary services	2 642	30 950	*	0,898		15	*	37 683	3 297	
70,72,76	Hotels, pers.& misc. repair serv.	33 136	96 046	*	0,903		4		34 059	12 042	
27	Printing and publishing	6 505	52 510	*	0,994		2		26 563	3 372	
20	Food and kindred products	3 267	66 746	*	1,165		4		26 376	1 323	
79	Amusement & recreation services	14 340	50 129	*	1,104		2		15 072	4 418	
24	Lumber and wood products	4 983	38 461	*	1,501	*	2		12 160	1 615	
32	Stone, clay, and glass products	1 506	18 376	*	0,986		5	*	10 388	872	
58	Eating & Drinking Places	13 654	42 945	*	0,174		2		9 954	3 243	
22	Textile mill products	1 204	10 248	*	0,451		6	*	8 148	981	
30	Rubber and misc. plastics products	1 332	19 450	*	0,599		5	*	6 893	484	
38	Instruments and related products	873	14 257	*	0,496		2		6 352	399	
75	Auto repair, services, and parking	17 997	17 997	*	0,500		2		4 728	4 845	
23	Apparel and other textile products	1 144	6 074		0,190		4		3 769	727	
25	Furniture and fixtures	1 639	12 928	*	0,754		0		2 424	315	
39	Miscellaneous manufacturing industries	1 226	5 678		0,431		1		2 043	452	
10	Metal mining	17	5 752		3,276		1		1 203	4	
29	Petroleum and coal products	156	3 134		0,623		2		1 088	56	
14	Nonmetallic minerals, except fuels	816	3 315		0,992		0		633	160	
31	Leather and leather products	322	1 553		0,403		1		355	75	
21	Tobacco products	8	1 050		0,818		0		185	1	
13	Oil & Gas Extraction	53	14		0,001		5	*	5	21	
	TOTAL	505 352	3 251 610		1,000				3 251 610	505 352	

Figure 5.1. Ohio Employment by Industry 1975-94



Sources: U.S. Bureau of the Census, *Public Employment, Series GE-No. 1*, various years. Washington, D.C.: USGPO. Regional Financial Associates.

Figure 5.2. Swedish Employment by Industry 1975-93



Note: Due to poor coverage of Services and Public Administration in Sweden in 1975 and 1978, employment in those sectors is seriously underrepresented for those years.

Source: Swedish National Central Bureau of Statistics.

Figure 5.3. Employment by Industry in Ohio and Sweden 1975 and 1993

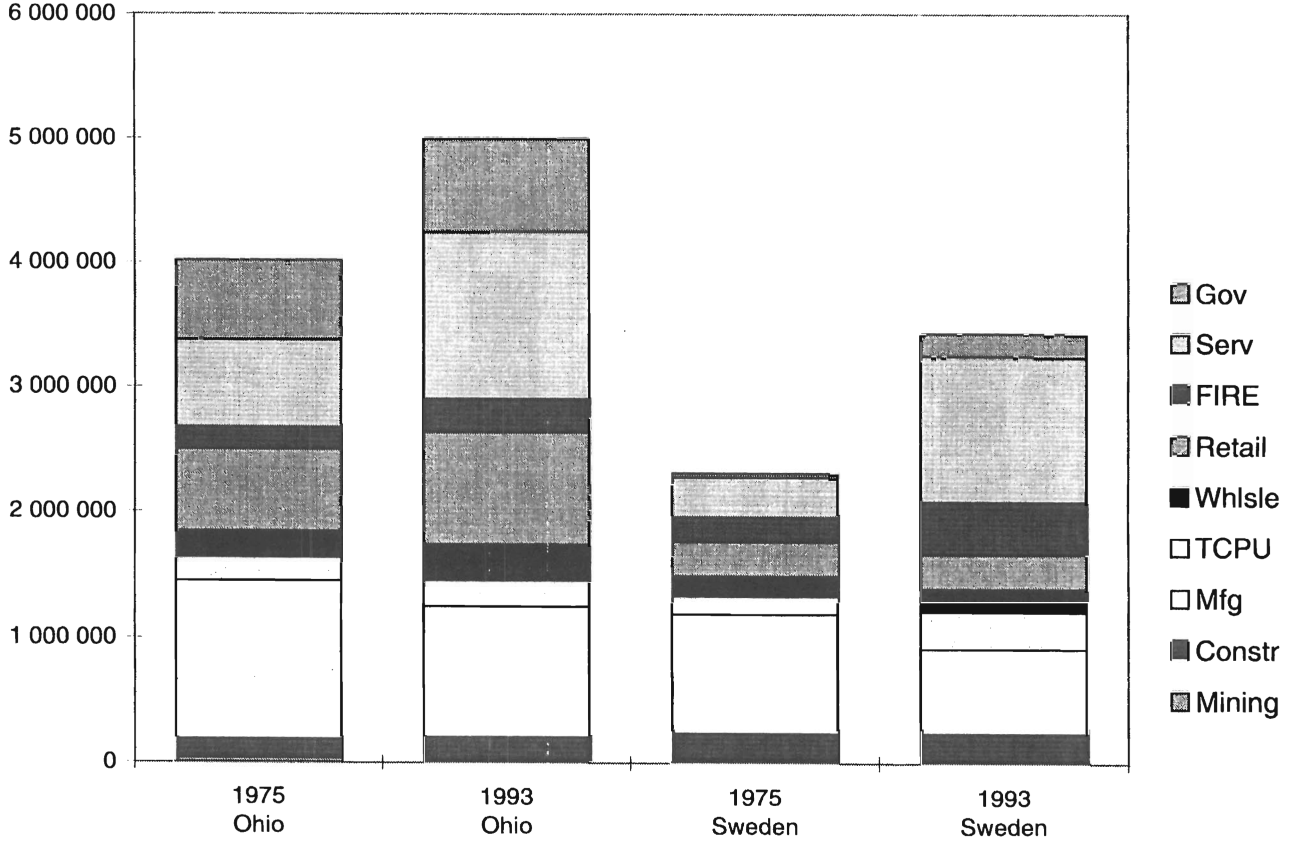
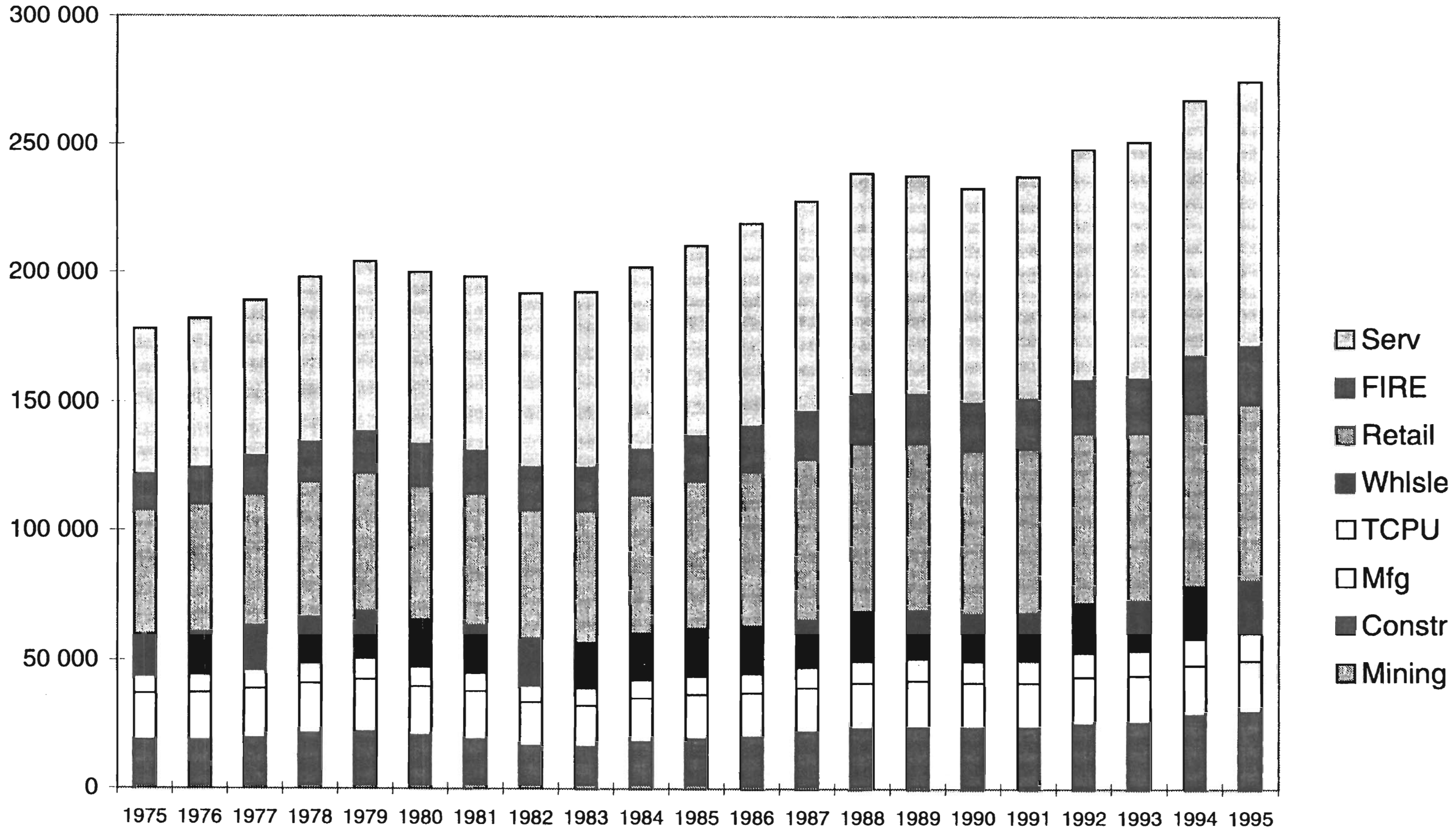
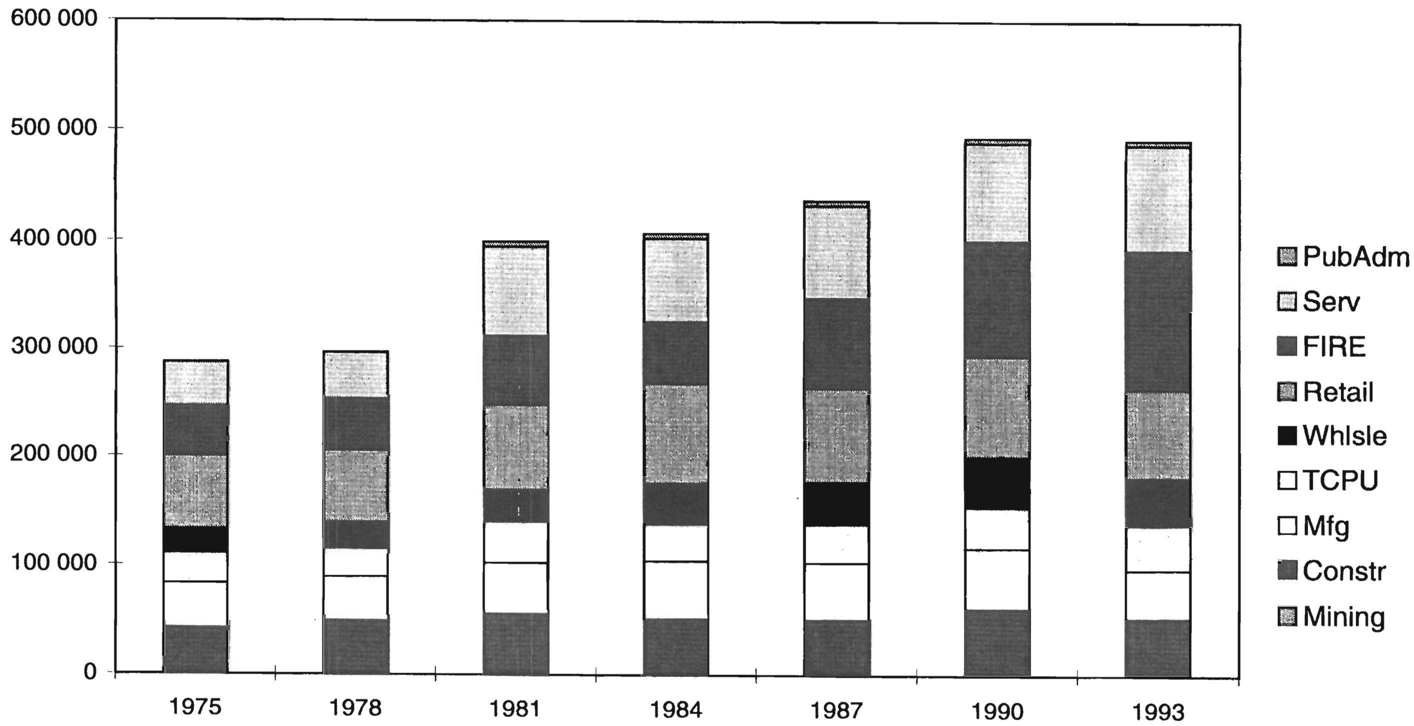


Figure 5.4. Ohio Establishments by Industry, 1975-95



Source: Regional Financial Associates.

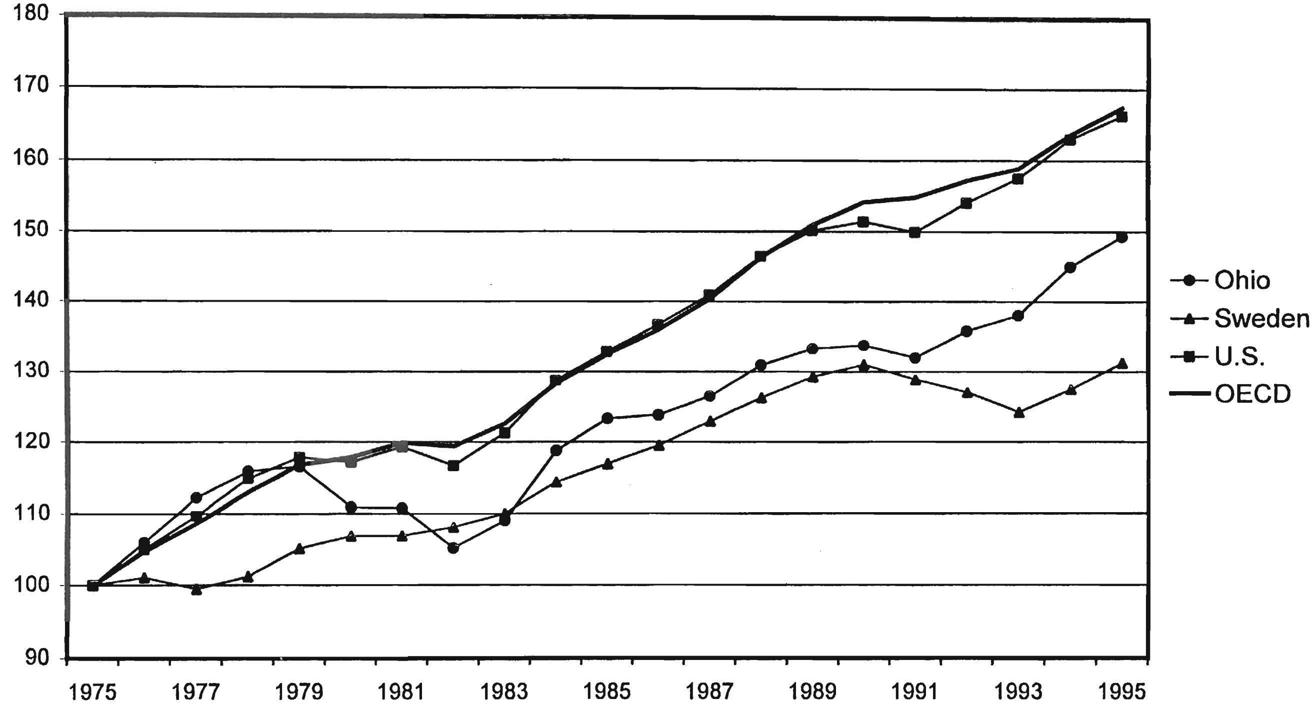
Figure 5.5. Swedish Establishments by Industry, 1975-93



Note: Due to poor coverage of Services and Public Administration in Sweden in 1975 and 1978, employment in those sectors is seriously underrepresented for those years.

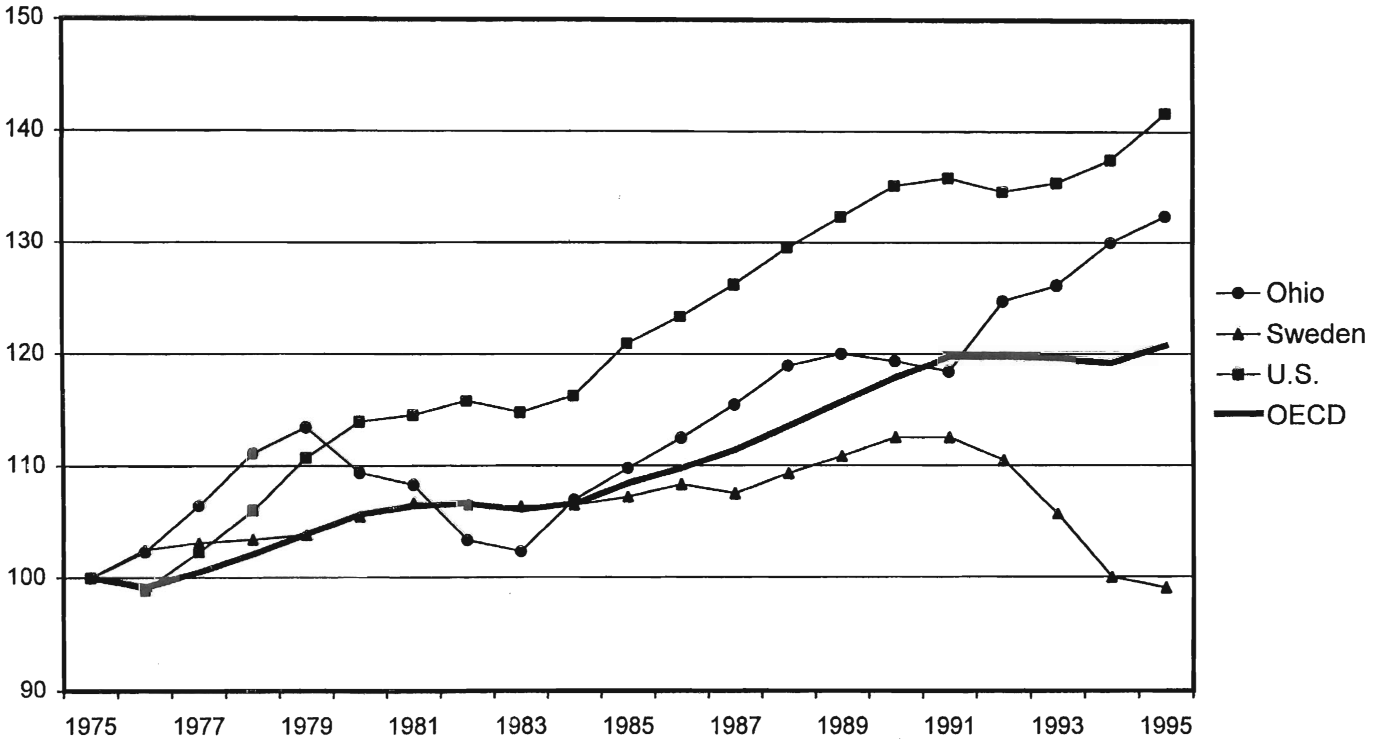
Source: Swedish National Central Bureau of Statistics.

Figure 5.6. GDP in Ohio, Sweden, United States and OECD, 1975-95. Index, 1975 = 100



Sources: Ohio: H.L. Friedenberg and R.M. Beemiller, "Comprehensive Revision of Gross State Product by Industry, 1977-94," *Survey of Current Business*, June 1997.
Sweden and United States: IMF, *International Financial Statistics,* 1991 and 1996. Washington, D.C.: IMF.
OECD: *National Accounts. Main Aggregates, Volume 1, 1960-1991*. Paris: OECD, 1993.
OECD, *Main Economic Indicators*, January 1996. Paris: OECD, 1996.

Figure 5.7. Civilian Employment in Ohio, Sweden, United States and OECD, 1975-95. Index, 1975 = 100



Sources: OECD, Sweden and United States: OECD, *Historical Statistics*, various issues.
Ohio: Regional Financial Associates.

CHAPTER 6

6. Host country characteristics and agglomeration in foreign direct investment[68]

6.1 Introduction

During the second half of the 1980s, foreign direct investment (FDI) became a major force in the global economy, reaching an unprecedented annual growth rate of approximately 25 percent. The percentage share of world FDI flows relative to global gross fixed capital formation doubled between 1985 and 1991, and sales of affiliates owned by multinational corporations (MNCs) exceeded world exports of goods and non-factor services in 1992 (UN, 1994). Despite the overwhelming empirical evidence of the increases in firms' foreign operations, locational issues have only recently been incorporated into economic modelling.

An overall framework to FDI is provided by Dunning's (1977) OLI-approach, relating microeconomic as well as macroeconomic variables to FDI. More rigorous modelling of the location of production based on externalities arising from firms' inability to fully appropriate the return to R&D investments, economies of scale, increased interaction between firms, and localized access to specific skills and capabilities, have been provided by, for instance, Krugman (1991a,b) and Venables (1993). If such factors gain in importance for firms' competitiveness, they seem to suggest that firms will increasingly concentrate production in geographically well-defined areas, i.e. agglomeration will arise.

The question addressed in this paper concerns how different host country characteristics affect the locational decision of overseas production. Particular attention is paid to the interaction effects of firm- and country-specific characteristics. The main objective is to examine if agglomeration patterns can be detected in Swedish FDI, and to which extent such agglomeration phenomena differs between industries.

[68] Written together with Roger Svensson, IUI.

As compared to previous studies in this field, the sample selection and methodology are extended. Notably, countries where firms have decided not to establish manufacturing affiliates are included in the sample, not only those where affiliate production actually takes place. We will therefore use estimation techniques that incorporate a censored dependent variable. This makes it possible to distinguish between factors that determine the probability of firms locating production in certain countries, and, on the other hand, how much firms will produce in those countries where affiliates have already been established. In the statistical analysis, a unique data set on Swedish MNCs is combined with country data for most OECD countries as well as the most important Latin American countries.

The chapter is organized as follows. Section 6.2 reviews the theoretical framework of FDI as well as earlier empirical results. The database and sample selection are described in section 6.3. In section 6.4, the econometric methods and the hypotheses are presented. The results are provided in section 6.5, while the final section concludes.

6.2 Foreign direct investment and agglomeration patterns

6.2.1 Theoretical background

The theoretical foundation of FDI is still rather fragmented, compiling bits and pieces from different fields of economics to elucidate the locational pattern of firms. The microeconomic foundation of most theories rests on the theory of the firm (Coase, 1937; Williamson, 1975, 1979) and the theory of the firm's internationalization (Hymer, 1960), i.e. transaction costs explanations are invoked. Such microeconomic explanations provide necessary conditions for FDI. They are, however, not sufficient since firms always have the option to substitute FDI for exports from the home country.

The locational literature focuses on why firms in a specific industry tend to be concentrated in certain geographically well-defined areas, even though costs are higher. The rationale for such agglomeration behavior is traditionally ascribed to the advantages arising from (a) demand and supply linkages, and (b) intra-industry technological and information spill-overs, as follows:[69]

Demand and supply linkages. The "new" location theory emphasizes "pecuniary" externalities, defined to be associated with demand and supply linkages, such as the possibility to use joint networks of suppliers and distributions (Krugman, 1991a,b). Economies characterized by high transportation costs, limited manufacturing production and weak economies of scale are shown in these models to have a dispersed manufacturing sector. On the other hand, low transportation costs, coupled with a large manufacturing sector and economies of scale, foster concentration of production.[70] The analysis of the location of firms is normally confined to the pattern *within* countries, although, and more appropriate for our purpose, the same line of reasoning can of course be applied to the location of firms *between* countries. For instance, Venables (1993) shows in a two-country model how low trade costs increase firms' sensitivity to differences in production costs, thereby making them more internationally "footloose". In the case of vertically linked industries, small parametric changes may then result in "catastrophic" effects where extensive relocation of firms leads to an agglomeration of industrial production into one single country.

Spill-overs. Another reason for agglomeration can be derived from the new growth theory (Romer, 1986; Sala-i-Martin, 1990). It is argued that knowledge enhancing activities can only partly be appropriated by firms, implying that an externality is created and diffused to other firms, thereby reducing their costs (Vernon, 1960; Griliches, 1979). The spill-over literature is closely linked to earlier research on public goods. Already Henderson (1974) argued that the rent firms derive from public goods - which enter their production functions as unpaid intermediate goods - induces entrance by firms. For regions where such spill-overs are abundant, it would constitute a locational advantage.

The most comprehensive framework with regard to FDI is the eclectic approach (Dunning, 1977), i.e. the OLI-theory, which - rather than providing a full theory - discusses the necessary conditions for FDI to take place. The OLI-theory is named after

[69] The idea is not new, already Dahmén (1950) stressed the importance of clustering, or in Dahmén's terminology, development blocks, in creating competitive advantages, a tradition pursued at the macro-level by, for instance, Porter (1990).

[70] If factor mobility is low, such agglomeration could be halted by increases in factor rewards.

the three main factors influencing FDI: ownership advantages, i.e. firm-specific assets are represented by O, while L stands for country-specific factors, and I refers to the internalization of firms' proprietary assets. The lack of markets for firm-specific assets tends to make transaction costs - or the risk of being exposed to "opportunistic behavior" (Williamson, 1975) - excessively high for arm's length contracts and similar arrangements, which induce internalization of production through FDI. Regarding the locational factors, the OLI-theory maintains that in order to attract FDI the recipient country has to offer some particular country-specific advantage. Such advantages are, for instance, sizable markets, skills or the cost of production factors, and policy-designed incentives.

The OLI-theory lacks variables that explain agglomeration tendencies. As mentioned above, R&D spill-overs, linkages to local networks and suppliers as well as the industrial structure and the skill level among employees have been assigned a crucial role in explaining agglomeration. Hence, in order to understand the distribution of production across countries, such local forces related to country- and industry-specific features must be included in the empirical model.

6.2.2 Previous empirical results

To what extent have agglomeration effects been confirmed in empirical research? Most empirical analyses test the impact of country-specific location factors on the flows of FDI (i.e. factors belonging to the L in the OLI-framework). For instance, Swedenborg (1979, 1982) suggests that the market size is one of the most important host country determinant of overseas production. Kravis and Lipsey (1982) and Veugelers (1991) conclude that size and geographical proximity exert a positive impact on the distribution of investments. With regard to openness, broadly defined as access to other countries' markets, evidence is more scattered. Kravis and Lipsey (1982) and Culem (1988) find that it has a positive influence on FDI, giving tentative support to the new locational theory, while Wheeler and Mody (1992) and Brainard (1993b) report opposite results and Veugelers (1991) fails to detect any significant impact. Factor costs seem to have very limited influence on FDI, at least among industrialized countries. In fact, Kravis and Lipsey (1982) report a pattern of "opposite attracts", i.e. firms in low wage industries invested in high-wage markets, where high wages were interpreted as reflecting high productivity. Swedenborg (1979, 1982) reports that high wages in the host country attract MNCs and Brainard (1993a) concludes that factor costs have no impact on the locational decision of FDI.[71]

Thus, from the studies cited above a number of variables can be distinguished that influence the locational choice of firms, although less light is shed on the tendencies towards agglomeration. One exception is the study by Wheeler and Mody (1992) where country characteristics, such as the quality of infrastructure, the degree of industrialization and the level of inward FDI into the respective market, are incorporated into the analysis as measures of agglomeration factors. It is contended that US investors regard such agglomeration factors as one of the major determinants of FDI. Wheeler and Moody also raise the question how economies that lack such attracting factors can overcome this drawback, since agglomeration - after a certain stage has been reached - seems to be a self- perpetuating process. As shown by Arthur (1986), a minor regional advantage could turn into a substantial clustering of a specialized industrial activity. Some further evidence of agglomeration is also found in the pattern of Japanese FDIs (Micossi and Viesti, 1991). Japanese firms have predominantly entered into industries in which the host countries have already revealed comparative advantages.

6.3 The database and sample selection

The data set on Swedish MNCs has been collected by the Industrial Institute for Economic and Social Research (IUI) in Stockholm at six different occasions since the mid-1960s. It contains detailed information about production, employment, R&D and the distribution between foreign and domestic units, as well as the extent and direction of external and internal trade flows. In the empirical analysis, only the three most recent surveys (1978, 1986 and 1990) are used since the emphasis is on the location undertaken by Swedish MNCs in the 1980s. Only countries for which we have export statistics of the individual firms are included in the analysis, i.e. the OECD countries

[71] The effects of disparate tax systems are frequently neglected in these studies. Location is, however, not immune to tax differences, although recent integration of markets has induced more of tax-neutrality, particularly with regard to corporate taxes (Modén, 1993).

in Europe and North America, and the major countries in Latin America.[72] This is, however, not a cause of great concern since more than 95 percent of the foreign production of Swedish MNCs is undertaken in these countries. Data on country and industry level, if not specified elsewhere, are taken from UN (1980, 1989, 1993) statistics.

In studying how different factors affect the pattern of foreign production, we introduce a methodological novelty. The model is based on the fact that the firm has to make two decisions simultaneously when locating overseas production: (1) Whether to establish a manufacturing affiliate in a country at all; (2) If an affiliate is established, what level of operation should then be chosen? The alternative to choosing a high level of production in a country may, in fact, be to locate no production there at all, rather than choosing a low level of production. Furthermore, the firm can always exit the market even if sunk costs are present, e.g. by selling or closing down the affiliate.

Previous studies have only considered countries where affiliate production actually takes place, which means that the first decision has been ignored. Since the two decisions are interrelated, systematic sample selection bias will be present and the parameter estimates will be both biased and inconsistent. We avoid this problem by including in our sample also countries where the firm has not established any manufacturing affiliates.

One could imagine countries where a certain firm would never invest. In particular lack of knowledge or experience of a country would deter investments. Table 6.1 shows the connection between the establishment of manufacturing affiliates abroad and the previous trade pattern of Swedish MNCs over the 1975-90 period. As many as 94 percent of all entries were located in markets to which the firms had previously exported. We could interpret this as if a certain amount of knowledge had been acquired through the firms' exports to the market. Countries to which firms export should therefore be strong candidates for FDI.[73] Exceptions to this pattern relate to industries where serious trade barriers have made export impossible, as in the gas (chemicals),

[72] EC countries: Germany, the Netherlands, Belgium, France, Italy, United Kingdom, Denmark, Spain and Portugal; EFTA countries: Norway, Finland, Switzerland and Austria; North America: the United States and Canada; Latin America: Argentina, Brazil and Mexico.

[73] It should be noted that affiliates are not established in all markets where the firm has previously exported.

concrete, food and textile (others) industries.

Table 6.1. Comparison between establishment of affiliates and firms' earlier exports, by industry, 1975-1990

Industry	No. of establishments	No. of obs. to which the firms had previous exports	Percent
Paper & pulp	44	43	99
Chemicals	73	62	85
Iron & steel	15	15	100
Metal products	35	31	89
Machinery	77	76	99
Electronics	108	107	99
Transports	16	16	100
Others [a]	50	42	84
All industries	418	392	94

Note: Every time a firm has established an affiliate in a host country, one observation is generated. Only firms which are included in two succeeding surveys are analyzed in the table, i.e. observations for 1990 (1986, 1978) are only included when a firm appears in the 1986 (1978, 1974) survey as well.
[a] 'Other' industries include the food, textile, paper products, wood products and concrete industries.

In the empirical analysis one observation is generated every time the firm has had previous export to a foreign market, irrespective of whether the firm has established any affiliates in the particular country. According to the sample criteria, a firm in the 1990 (1986, 1978) survey is only included in the sample when it appears in the 1986 (1978, 1974) survey as well.

6.4 Econometric specifications and hypotheses for empirical testing

6.4.1 Econometric methods

The dependent variable is net sales of firm *i's* affiliates located in country *j* at time *t*, NS_{ijt}.[74] *NS* is divided with total sales of the firm, TS_{it}, in order to control for historical factors as well as economies to scale on the firm level. This is also a way to avoid

[74] Net sales = Gross sales - Imports from the parent company.

heteroscedasticity. The variable *NS/TS* is characterized by a large share of zeroes (more than 60%), since countries where firms have no affiliate production are included as well as countries where affiliates are established. Under these circumstances, one appropriate statistical method for estimating the variation in overseas production is the Tobit method via maximum likelihood procedures (Tobin, 1958):

$$\frac{NS_{ijt}^*}{TS_{it}} = \beta_0 + Z'\beta_1 + \epsilon_{ijt} \, , \tag{6.1a}$$

$$\frac{NS_{ijt}}{TS_{it}} = \begin{cases} \dfrac{NS_{ijt}^*}{TS_{it}} & if \; \dfrac{NS_{ijt}^*}{TS_{it}} > 0 \\ 0 & if \; \dfrac{NS_{ijt}^*}{TS_{it}} \leq 0 \end{cases} \, . \tag{6.1b}$$

Z is a vector of attributes related to either the MNC or the host country, while β_1 denotes the vector of parameters showing the impact of the Z's on *NS/TS*. The latent variable $(NS/TS)^*$ can be interpreted as an index of the propensity to produce in a specific host country. The residuals are assumed to have the properties $\epsilon \sim (0, \sigma_\epsilon^2)$, $E(\epsilon_{hjt}\epsilon_{ijt})=0$ for $h \neq i$ and $E(\epsilon_{ijt}\epsilon_{ikt})=0$ for $j \neq k$. It should be noted that $E(\epsilon_{ijs}\epsilon_{ijt}) \neq 0$ for $s \neq t$, since a firm which has a high production in country j at time s, is also expected to have a high production at time t. This will, however, not yield inconsistent parameter estimates.[15]

If only countries where affiliate production actually takes place are considered and observations are omitted for which $NS/TS=0$, this is equivalent to omitting all observations for which $\epsilon_{ijt} \leq -(\beta_0+Z'\beta_1)$. This implies that if ϵ_{ijt} in the population has a zero mean and a constant variance, the sample error μ_{ijt} will not have these properties because observations have been systematically rather than randomly excluded.

[15] The efficiency of the parameter estimates will be reduced by this possible autocorrelation. In the model, we use unbalanced panel data for three time periods, i.e. it is far from always that a combination of a specific firm and country is included the maximum number of three times in the sample. This will partly reduce the autocorrelation problem. To further reduce the autocorrelation we could specify fixed effects for each combination of firm and country in the form of additive dummies, but we would then suffer from a large loss of degrees of freedom and the estimation procedures would be complex. In the vector Z, however, a lot of characteristics for individual firms as well as countries are included which partly may capture fixed effects.

The estimates of the Tobit parameters reflect both changes in the probability of being above the limit and changes in the value of the dependent variable if it is already above the limit. The decomposition is shown in McDonald and Moffitt (1980), but the problem is that the two separate effects will always have the same sign and significance. There may be cases where the probability and marginal effects of a certain explanatory variable differ. It is, however, possible to estimate these impacts separately by using a selection bias corrected regression method, SBCR (Fomby *et al.*, 1986). First, a probit function is estimated via maximum likelihood procedures for all observations, both $NS/TS>0$ and $NS/TS=0$, in order to obtain the probability effects:

$$F^{-1}(Pr(Y)_{ijt}) = J_{ijt} = \alpha_0 + Z'\alpha_1 \;, \tag{6.3}$$

where F^{-1} is the inverse of the cumulative standard normal distribution and Y takes the value of one if $NS/TS>0$, and zero if $NS/TS=0$. $\Pr(Y)_{ijt}$ represents the probability that firm i has production in country j at time t, given the values of the explanatory variables. The α's are parameters that show the influence of the independent variables on the probability that the firm locates production in a certain country. From these estimates, a sample selection correction variable λ, called Heckman's lambda, is computed for all observations:

$$\lambda_{ijt} = \frac{f(-J_{ijt})}{(1 - F(-J_{ijt}))} \;, \tag{6.4}$$

where f and F are, respectively, the density and cumulative standard normal distribution function. Then, the sample is restricted to observations for which $NS/TS>0$, and a usual OLS regression is run, in which the estimated correction variable, $\tilde{\lambda}$, is included:

$$\frac{NS_{ijt}}{TS_{it}} = \gamma_0 + Z'\gamma_1 + \sigma\tilde{\lambda}_{ijt} + v_{ijt} \;. \tag{6.5}$$

The estimated γ's are here the marginal effects of the explanatory variables on overseas production.[76] Since Heckman's lambda is included, this OLS equation will yield consistent parameter estimates. The estimated standard errors will, however, be inefficient since we use the estimated rather than the actual value of λ. A White (1980) correction for heteroscedasticity is therefore required in order to obtain efficient standard errors of the estimated parameters. The residuals in equation 6.4 are then assumed to have the properties $\nu \sim N(0, \sigma_\nu^2)$, $E(\nu_{hjt}\nu_{ijt})=0$ for $h \neq i$ and $E(\nu_{ijt}\nu_{ikt})=0$ for $j \neq k$, but, similar to ϵ, $E(\nu_{ijs}\nu_{ijt}) \neq 0$ for $s \neq t$.

The advantage of applying SBCR as compared to the Tobit method can be summarized as follows: (1) The marginal and probability effects are separable and will *not* necessarily be equal in SBCR, whereas in the case of Tobit these two sets of effects are treated as identical; (2) The Tobit method provides a continuous distribution of the predicted values of the dependent variable. The SBCR method allows the first positive predicted observation to "jump" from zero to a high positive value.

6.4.2 Hypotheses for exogenous variables

The explanatory variables included in the model are primarily derived from the OLI-framework, extended to incorporate country-specific agglomeration factors. The focus will be on the interaction between firm- and country-specific determinants of FDI. All variables except those measuring agglomeration and the previous trade pattern of the investing firm have been used in earlier studies.

Agglomeration. In line with the discussion in section II, a variable measuring country agglomeration effects ($AGGL_{bjt}$) is introduced. It is defined as the share of employees in industry *b* - in which the investing firm operates - of all employees in the manufacturing sector in host country *j* at time *t*.[77] For two reasons, this variable is

[76] It should be noted that the probit and corrected OLS equations include the same explanatory variables in the vector Z. A possible practical problem is then multicollinearity between Z and λ. There is no theoretical basis that such problems must arise, however, since the latter variable is a ***non-linear*** combination of Z while OLS is a *linear* estimation technique. By excluding any of the firm variables in the OLS equation, it was verified that the results for the remaining parameter estimates were robust.

[77] Industry *b* for the agglomeration variable refers to the 3-digit ISIC-level for engineering and 2-digit level for other industries. It is difficult to collect country data on a finer industry level, although the industry classification for the Swedish MNCs can be obtained on an extremely fine level. It would be preferable to have industry data on a regional level in each country, but information on the regional

divided with a weighted mean of the share of employees in industry *b* in all countries: First, some industries may be large in almost all countries and, second, some industries are more labor intensive than others. Such industries would then receive a lower value if we had chosen the share of output instead.

In our view, this variable should capture local support systems and networks within industries, but it could also be interpreted as a proxy for possible intra-industry R&D spill-overs. Thus, if the coefficient of *AGGL* turns out to be significantly positive, it suggests a presence of agglomeration effects.[78] Insignificant or negative parameter estimates imply that firms primarily invest in countries which have limited production of similar products, indicating that other reasons to invest abroad are more important. This specification of the agglomeration variable allows a more disaggregated analysis as compared to the approach taken by Wheeler and Mody (1992) and Micossi and Viesti (1991).[79]

Additional host country characteristics. The other country variables included in the model are as follows. Large markets, measured by GDP, are supposed to capture demand and scale effects. GDP_{jt} has received support in most empirical analyses, and is expected to have a positive influence on host country production. Moreover, a variable measuring the relative endowment of skilled labor in the host country is included. This is defined as the number of research scientists, engineers and technicians per 1000 of the population ($RSET_{jt}$). Host countries with high *RSET* values are expected to promote FDI, especially by R&D intensive firms.

A modified version of the Wheeler and Mody (1992) index measuring openness of the host country has also been included ($OPEN_{jt}$).[80] *OPEN* takes on values from 1 to 10,

location of the Swedish-owned foreign affiliates were not available.

[78] One may argue that there should be a simultaneous relationship between *NS/TS* and *AGGL*, e.g. if firms in electronics allocate more FDIs to Germany, then this industry will get a larger share of total manufacturing employees in Germany. This is, however, not a problem of great concern, since our model analyzes location of affiliate production for individual firms. It is quite farfetched to believe that an individual firm would affect a characteristic aggregated on industry and country level.

[79] It could be argued that *AGGL* partly measures comparative advantages, e.g. supply of skilled labor or large demand of the firm's products in the host country. By including other host country variables, however, we will control for such factors.

[80] This index includes (1), limits to foreign ownership and, (2), government requirements that a certain percentage of a specific type of local components must be used in production. The Wheeler-Mody index was constructed for the US and it has been modified to conform better with the Swedish situation

where 10 means high openness. Here we assume that protection encourages MNCs to locate production in the host country. Another index measures the physical distance between Sweden and the host country ($DIST_{jt}$). It is assumed that *DIST* captures "how difficult it is to do business with a particular country" from the Swedish point of view (Nordström, 1991). The higher the value of *DIST*, the lower the probability, as well as the intensity, to produce in the country.[81]

According to the discussion in section 6.3, establishment of production should be facilitated if the firm already has some information about the host country, since knowledge tends to reduce the risk associated with foreign investment. The historical trade pattern of the firm indicates whether such knowledge has been acquired. Here, it is represented by the parent exports of finished goods by firm *i* to country *j* in period *t-1* ($XF_{ij,t-1}$). To control for scale factors on firm level and historical factors, XF_{t-1} is weighted with the inverse of the firm's total sales in period *t-1*. By using the lagged value of exports, we make an attempt to avoid simultaneity problems.[82] Large exports at an earlier stage are expected to have a positive influence on the location of production (Aharoni, 1966; Johansson and Vahlne, 1977).

Firm characteristics. Some firm characteristics are included as control variables. In accordance with the OLI-theory, ownership advantages are expected to create absolute advantages vis-à-vis competitors.[83] We use R&D intensity (RD_{it}) - defined as total R&D expenditures divided by total sales of the firm - and the average wage (LS_{it}) in the home country part of the MNC, to capture such advantages. The former is argued to capture the technological intensity of the firm, while the latter should be correlated with the human capital within the company. Both *RD* and *LS* should exert a positive impact on the propensity to produce abroad.

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by including the data on trade barriers in Leamer (1990).

[81] This variable takes both (1), geographical and, (2), cultural and linguistic distance into account. The former should favor production relative to exports to avoid costs of shipping over long distances, while the latter should exert a negative impact on both exports and production according to the transactional approach. In practice, this means the following ranking: Nordic countries, other North European countries, North America, South European countries, and, finally, Latin America.

[82] In Svensson (1993), it is discussed and shown how foreign production and exports are simultaneously related to each other.

[83] It is expected that such advantages should, in the first place, affect the overall presence on foreign markets (probit equation) and not the distribution of production across countries (OLS equation).

Another firm-specific variable, high initial capital costs (HIC_{it}), limits competition since it makes it costly for new firms to enter the market. *HIC* therefore renders a competitive advantage for firms already in the market and is expected to exert a positive impact on overseas production. *HIC* is the average plant size, measured as the average book value of real estate, equipment and tools, of the MNC's foreign affiliates.[84]

Dummies. By including additive dummy variables, we examine whether any shifts in the level of the dependent variable occur over time or across regions.[85] The analysis also considers whether there are any industry- or firm-specific fixed effects to explain the variation in foreign production. This is done by assigning additive dummies for different industries in model (I) and firms in model (II).[86]

In models (I) and (II), all parameters to the explanatory variables are restricted, i.e. they are assumed to have the same value for all industries. In an additional run of model (II), however, the parameter of *AGGL* is allowed to vary across high and low technology industries.[87] This is accomplished by assigning an interaction dummy to *AGGL* for one of the industry groups.

6.5 Results of the estimations

The results of the Tobit estimations are shown in Table 6.2. The parameter to the agglomeration variable, *AGGL*, is positive and at least significant on the 10-percent level. The more important the industry of the investing firm is in the host country, the more the firm's affiliate will produce in that country, and the higher the probability that the firm has established any affiliate there. This result gives some support to the view

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[84] This definition is made under the assumption that each affiliate operates at the optimal level of scale.

[85] The regions are the EC, EFTA, North America (Nam) and Latin America (Lam).

[86] The industry dummies are assigned on the 4-digit ISIC-level for engineering and 3-digit level for other industries. The treatment of engineering is motivated by the fact that a majority of the firms belongs to this industry. When controlling for firm-specific effects, MNCs included in at least two of the three surveys are given an additive dummy. This means that we control for 27 different firms, which cover more than 75 percent of the observations. There is no use to assign dummies to MNCs which only appear in one survey, since there is little variation left between firms.

[87] The group of high-technology industries are pharmaceuticals, plastic and rubber products, and the entire engineering industry. The low-technology group includes food, textiles, wood products, paper & pulp, iron & steel and basic chemicals.

that agglomeration forces partly determines the location of manufacturing affiliates. It is, however, even more clearly confirmed that the previous trade pattern of the firm affects the location of production. The parameter to the export variable, *XF/TS*, is significant at the 1-percent level in both runs.

Both market size, *GDP*, and the endowment of skilled labor, *RSET*, exert a positive and clearly significant impact on affiliate production. This is in accordance with the hypotheses above. The openness of the host country, *OPEN*, has the expected negative impact on affiliate production, but the parameter is never significant. It is also shown that the physical distance between Sweden and the host country matters. The parameter of *DIST* has an expected negative sign and is significant at the 5-percent level in both models.

Turning to the firm-specific control variables, the R&D intensity, *RD*, labor skill, *LS*, as well as scale economies on plant level, *HIC*, have the expected positive connection to foreign production, but the parameters are not always significant. Not surprisingly, the coefficients of the firm variables are strongly affected by the inclusion of firm-specific effects in model (II). The impact of *RD* is then significant, while the influences of *LS* and *HIC* are no longer significant.

Table 6.3 shows the results of the SBCR estimations, where the probability and marginal effects are separated. *AGGL* exerts a clearly significant impact on the probability that the firm locates affiliates in the host country, while the marginal effect is only significant in model (II). Taken together, this suggests that agglomeration effects are present in FDI. The parameters of *XF/TS*, *GDP* and *RSET* are all positive and, with one exception, significant at the 5-percent level in both the probit and the OLS equations in models (I) and (II). In contrast to the Tobit estimates, *OPEN* now turns out to have a significant impact on the level of production in the affiliates in the OLS equation, while it has no influence on the dichotomous location decision in the probit equation. The parameter of *DIST* has the expected negative sign, but the significance is stronger in the probit equation. Once again, the coefficients of the firm control variables change their magnitude and significance when comparing models (I) and (II), especially for *LS* and *HIC*. The p-value varies substantially between the probit and OLS equations.

In general, the differences are larger between the probit and OLS estimates than between models (I) and (II) for a given equation. This suggests that SBCR is a better model than the more restrictive Tobit model. Almost all variables except *OPEN* exert a significant impact on the dichotomous location decision in the probit equation. On the other hand, the parameters of all host country characteristics, except *AGGL* and *DIST*, are strongly significant in the OLS equation, while the results for the firm variables are weak as expected.

When we allow the parameter of *AGGL* to vary across industry groups in Table 6.4, *AGGL* has a positive, and significant, influence on the dichotomous location decision in the probit equations in high-tech industries, but not in low-tech industries. In the OLS equations, the coefficient of *AGGL* is not significant in any of the industry groups in model (I), which can be compared with the main estimation in Table 6.3. In model (II), the parameter is significant on the 5-percent level for both groups. Furthermore, the difference in the parameter of *AGGL* between the groups is never significant in any of the four runs. On the whole, however, it suggests that agglomeration effects are somewhat more prevalent in high-tech industries. The results for the other explanatory variables (appendix Table 6.7) are analogous to those in models (I) and (II) (Table 6.3).

6.6 Concluding remarks

The statistical analysis shows that overseas operations by Swedish firms are positively affected by host countries having large production in the same industry that the investing firm belongs to. Such agglomeration influences are strongest in technologically more advanced industries. Hence, the role allotted in contemporary research to supply and demand linkages, as well as knowledge spillovers, receives support in the statistical analysis. However, other forces related to comparative advantages and intra-industry specialization may also show up as agglomeration.

Yet, the remaining host country variables, except for openness, all exert a stronger impact on the localization of production. This is particularly obvious with regard to the previous trade pattern of the firm, as well as the market size and labor skill in host countries.

The sample selection and methodology were extended compared to previous studies. The sample also included countries where the firm had no production, which means that estimation techniques that incorporate a censored dependent variable have been used. This allowed us to analyze separately the two decisions that firms have to take as they consider overseas production; First, whether to locate production in certain host countries at all, and, second, how much to produce if affiliates are established. The statistical analysis show that these two decisions are partly determined by different factors.

If economies of agglomeration turn out to be increasingly important in firms' investment decisions, according to the new growth theory, this could have repercussions on the rate of growth across countries. Multiple equilibrium situations are possible, where countries, or regions, are trapped in either virtuous or vicious growth cycles. Although the results of the above analysis are based on the investment patterns of Swedish MNCs, we believe they have a general application to MNCs of other countries.

Table 6.2. Estimation results of the Tobit method (equation 6.1)

Method = Tobit	Dependent variable = *NS/TS*	
Independent variables	Model (I)	Model (II)
AGGL	1.207 ** (0.480)	0.871 * (0.463)
$(XF/TS)_{t-1}$	21.04 *** (7.44)	32.94 *** (8.01)
GDP	9.94 E-5 ** (4.31 E-5)	1.05 E-4 ** (4.22 E-4)
RSET	0.321 ** (0.157)	0.329 ** (0.157)
OPEN	-0.224 (0.233)	-0.217 (0.232)
DIST	-0.067 *** (0.024)	-0.068 *** (0.023)
RD	22.88 (15.21)	47.82 *** (14.95)
LS	0.021 *** (7.09 E-3)	5.65 E-3 (8.02 E-3)
HIC	7.77 E-3 *** (2.66 E-3)	4.56 E-3 (3.92 E-3)
Log likelihood ratio	1068	1187
No. of observations	1330	1330
Left censored obs.	769	769

Note: Standard errors in parentheses. ***, ** and * indicate significance at 1, 5 and 10 percent respectively. Intercept and dummies for time, regions and industries in model (I) are shown in appendix Table 6.5, while intercept and dummies for time regions and firms in model (II) are shown in appendix Table 6.6.

Table 6.3. Estimation results of the SBCR method (equations 6. 2-6.4)

Method = SBCR	Probit	OLS	Probit	OLS
Dependent variable	*Y*	*NS/TS*	*Y*	*NS/TS*
Independent variables	Model (I)		Model (II)	
AGGL	0.261 ** (0.111)	8.62 E-3 (0.013)	0.242 ** (0.114)	0.020 *** (7.72 E-3)
$(XF/TS)_{t-1}$	3.816 ** (1.624)	0.499 * (0.257)	6.674 *** (1.737)	0.597 ** (0.233)
GDP	2.72 E-5 *** (9.98 E-6)	4.12 E-6 *** (9.71 E-7)	2.73 E-5 *** (1.02 E-5)	4.00 E-6 *** (7.49 E-7)
RSET	0.084 ** (0.038)	9.64 E-3 *** (3.45 E-3)	0.097 ** (0.039)	8.03 E-3 *** (2.75 E-3)
OPEN	-0.059 (0.054)	-9.50 E-3 *** (3.05 E-3)	-0.057 (0.056)	-0.011 *** (2.73 E-3)
DIST	-0.014 *** (5.31 E-3)	-1.03 E-3 * (5.30 E-4)	-0.015 *** (5.48 E-3)	-1.13 E-3 ** (4.47 E-4)
RD	9.509 *** (3.344)	0.233 (0.421)	14.81 *** (3.46)	0.082 (0.396)
LS	6.47 E-3 *** (1.55 E-3)	8.11 E-5 (2.75 E-4)	3.20 E-3 * (1.84 E-3)	-3.44 E-4 * (1.89 E-4)
HIC	1.89 E-3 *** (5.97 E-4)	1.52 E-4 * (9.56 E-5)	8.46 E-4 (9.27 E-4)	-4.08 E-5 (6.72 E-5)
λ	---	0.079 (0.053)	---	0.086 ** (0.037)
F-value	---	7.48	---	8.80
Adjusted R^2	---	0.29	---	0.37
No. of observations	1330	561	1330	561
No. of *Y*=0	769	---	769	---
No. of wrong predictions (percent)[a]	28.5	---	25.6	---

Note: Standard errors in parentheses. ***, ** and * indicate significance at 1, 5 and 10 percent respectively. Intercepts and dummies for time, regions and industries in model (I) are shown in appendix Table 6.5, while intercepts and dummies for time, region and firms in model (II) are shown in appendix Table 6.6.

[a] at critical probability of 0.5.

Table 6.4. Testing the impact of *AGGL* across industry groups

Method = SBCR		Probit	OLS	Probit	OLS
Dependent variable		*Y*	*NS/TS*	*Y*	*NS/TS*
Industries		Model (I)		Model (II)	
AGGL	High-tech	0.361 *** (0.135)	0.015 (0.016)	0.267 ** (0.127)	0.022 ** (0.010)
	Low-tech	0.151 (0.139)	2.93 E-3 (0.012)	0.211 (0.134)	0.018 ** (8.76 E-3)

Note: Standard errors in parentheses. ***, ** and * indicate significance at 1, 5 and 10 percent respectively. Complete estimations of the parameters to the explanatory variables are shown in appendix Table 6.7. Intercepts and dummies for time, regions and industries in model (I) are shown in appendix Table 6.8. Intercepts and dummies for time, regions and firms in model (II) are shown in appendix Table 6.9.

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Appendix

Table 6.5. Supplement to Tables 6.2 and 6.3. Intercepts and dummies for time, regions and industries in model (I)

Method	Tobit		Probit		OLS	
Dependent variable	*NS/TS*		*Y*		*NS/TS*	
Dummies	Parameter	Std. error	Parameter	Std. error	Parameter	Std. error
Intercept	-0.092 *	0.048	-1.49 **	0.621	4.95 E-3	0.105
Time dummy 1978	0.014	9.01 E-3	0.344 ***	0.119	-1.37 E-3	0.016
Time dummy 1986	0.014	7.38 E-3	0.343 ***	0.097	-8.18 E-4	0.016
Dummy EFTA	-0.064 ***	0.011	-0.704 ***	0.136	-0.070 ***	0.024
Dummy Nam	-0.034 **	0.014	-0.303	0.185	-0.046 ***	0.013
Dummy Lam	0.037 *	0.021	0.844 ***	0.262	8.27 E-3	0.030
Industry dummy 1	-0.018	0.017	-0.540 ***	0.209	4.46 E-3	0.040
Industry dummy 2	-0.016	0.017	-0.680 ***	0.224	0.038	0.034
Industry dummy 3	3.58 E-4	0.013	-0.151	0.172	4.52 E-3	0.010
Industry dummy 4	-0.033	0.024	-0.596 **	0.295	-0.015	0.031
Industry dummy 5	0.012	0.017	-0.170	0.229	0.028	0.020
Industry dummy 6	3.20 E-3	0.019	0.353	0.263	-3.80 E-3	0.015
Industry dummy 7	-0.036	0.027	-0.667 *	0.348	-0.022	0.031
Industry dummy 8	0.076 ***	0.017	1.77 ***	0.279	0.059	0.052
Industry dummy 9	0.027	0.019	-0.048	0.244	0.050 **	0.024
Industry dummy 10	-0.056 ***	0.021	-0.757 ***	0.264	-0.051	0.030
Industry dummy 11	-0.048 **	0.020	-0.555 **	0.251	-0.049 *	0.028
Industry dummy 12	-0.013	0.017	-0.199	0.219	-0.012	0.016
Industry dummy 13	0.053 **	0.025	0.906 **	0.383	0.047	0.032
Industry dummy 14	0.019	0.017	0.483 **	0.229	0.015	0.019
Industry dummy 15	7.78 E-3	0.019	0.117	0.252	8.64 E-3	0.017
Industry dummy 16	-0.127 ***	0.037	-2.32 ***	0.469	-0.069	0.088
Industry dummy 17	-0.023	0.019	-0.500 **	0.240	-0.013	0.022
Industry dummy 18	0.019	0.023	-0.269	0.299	0.047	0.053
Industry dummy 19	3.60 E-3	0.018	0.148	0.228	3.44 E-4	0.011
Industry dummy 20	0.049	0.037	-0.476	0.529	0.197 ***	0.051
Industry dummy 21	-0.021	0.028	-0.649 *	0.360	0.084	0.089

Note: ***, ** and * indicate significance at 1, 5 and 10 percent, respectively. The EC is the reference group for the region dummies and 1990 is the reference period.

Table 6. 6. Supplement to Tables 6.2 and 6. 3. Intercepts and dummies for time, regions and firms in model (II)

Method	Tobit		Probit		OLS	
Dependent variable	*NS/TS*		*Y*		*NS/TS*	
Dummies	Parameter	Std. error	Parameter	Std. error	Parameter	Std. error
Intercept	-0.053	0.049	-1.54 **	0.646	0.111	0.083
Time dummy 1978	0.014	8.86 E-3	0.436 ***	0.122	-0.015	0.012
Time dummy 1986	7.03 E-3	7.95 E-3	0.286 ***	0.107	-0.018 *	0.010
Dummy EFTA	-0.064 ***	0.011	-0.738 ***	0.140	-0.070 ***	0.018
Dummy Nam	-0.033 **	0.014	-0.327 *	0.192	-0.042 ***	0.011
Dummy Lam	0.036 *	0.021	0.906 ***	0.270	2.96 E-3	0.024
Firm dummy 1	0.053 ***	0.017	1.35 ***	0.254	0.032	0.032
Firm dummy 2	0.044 ***	0.015	1.06 ***	0.226	0.031	0.025
Firm dummy 3	0.024	0.018	0.891 ***	0.248	7.60 E-4	0.024
Firm dummy 4	-0.095 **	0.038	-1.94 ***	0.495	-0.017	0.049
Firm dummy 5	0.018	0.016	0.352 *	0.211	3.51 E-3	0.020
Firm dummy 6	0.086 ***	0.016	2.25 ***	0.267	0.041	0.048
Firm dummy 7	0.034 **	0.016	0.374 *	0.204	0.018	0.018
Firm dummy 8	0.066 ***	0.019	1.32 ***	0.269	0.026	0.035
Firm dummy 9	-0.015	0.021	2.31 E-3	0.257	-0.040 **	0.016
Firm dummy 10	-0.025	0.023	-0.157	0.280	-0.044	0.028
Firm dummy 11	-0.030	0.025	-0.488	0.323	-7.03 E-3	0.019
Firm dummy 12	-0.148 ***	0.036	-2.66 ***	0.474	-0.044	0.073
Firm dummy 13	-0.070 **	0.027	-0.867 **	0.343	-0.062 **	0.028
Firm dummy 14	0.049 ***	0.015	1.37 ***	0.232	0.031	0.030
Firm dummy 15	-6.26 E-3	0.021	0.069	0.264	-0.028	0.020
Firm dummy 16	0.041 *	0.022	0.868 ***	0.299	0.019	0.026
Firm dummy 17	0.059 ***	0.022	0.530 *	0.300	0.077 ***	0.026
Firm dummy 18	-0.025	0.029	-0.264	0.367	-0.043 **	0.020
Firm dummy 19	-0.028	0.020	-0.175	0.260	-0.032 ***	0.012
Firm dummy 20	-8.26 E-3	0.023	0.299	0.276	-0.069 ***	0.023
Firm dummy 21	-0.041	0.025	-0.162	0.310	-0.076 ***	0.020
Firm dummy 22	0.058 **	0.028	0.363	0.374	0.083 **	0.033
Firm dummy 23	-6.80 E-3	0.022	0.086	0.276	-0.020	0.015
Firm dummy 24	8.02 E-3	0.029	0.801 **	0.387	-0.021	0.028
Firm dummy 25	0.017	0.026	0.281	0.337	3.62 E-3	0.032
Firm dummy 26	9.68 E-3	0.046	-1.06	0.715	0.444 ***	0.040
Firm dummy 27	0.070 ***	0.027	-1.08 ***	0.364	-0.036	0.089

Note: ***, ** and * indicate significance at 1, 5 and 10 percent, respectively. The EC is the reference group for the region dummies and 1990 is the reference period.

Table 6.7. Supplement to Table 6.4. Parameter estimates of the explanatory variables

Method = SBCR	Probit	OLS	Probit	OLS
Dependent variable	*Y*	*NS/TS*	*Y*	*NS/TS*
Independent variables	Model (I)		Model (II)	
AGGL	0.361 *** (0.135)	0.015 (0.016)	0.267 ** (0.127)	0.022 ** (0.010)
AGGL×Dummy Low-tech	-0.211 (0.160)	-0.013 (0.012)	-0.057 (0.128)	-3.88 E-3 (0.011)
$(XF/TS)_{t-1}$	3.72 ** (1.63)	0.508 ** (0.254)	6.71 *** (1.74)	0.593 ** (0.234)
GDP	2.65 E-5 *** (1.14 E-5)	4.14 E-6 *** (9.37 E-7)	2.71 E-5 *** (1.17 E-5)	3.96 E-6 *** (7.37 E-7)
RSET	0.083 ** (0.038)	9.80 E-3 *** (3.42 E-3)	0.096 ** (0.040)	7.92 E-3 *** (2.71 E-3)
OPEN	-0.063 (0.054)	-9.82 E-3 *** (3.13 E-3)	-0.058 (0.056)	-0.011 *** (2.73 E-3)
DIST	-0.015 *** (5.32 E-3)	-1.08 E-3 * (5.28 E-4)	-0.015 *** (5.49 E-3)	-1.12 E-3 ** (4.46 E-4)
RD	8.69 ** (3.40)	0.215 (0.412)	14.63 *** (3.49)	0.064 (0.390)
LS	6.67 E-3 *** (1.56 E-3)	1.12 E-4 (2.78 E-4)	3.20 E-3 * (1.85 E-3)	-3.53 E-4 * (1.94 E-4)
HIC	1.87 E-3 *** (5.97 E-4)	1.57 E-4 * (9.53 E-5)	8.38 E-4 (9.27 E-4)	-4.23 E-5 (6.78 E-5)
λ	---	0.084 * (0.052)	---	0.084 ** (0.037)
F-value	---	7.28	---	8.57
Adjusted R^2	---	0.29	---	0.37
No. of observations	1330	561	1330	561
No. of *Y*=0	769	---	769	---
No. of wrong predictions (percent)[a]	28.3	---	25.6	---

Note: Standard errors in parentheses. ***, ** and * indicate significance at 1, 5 and 10 percent, respectively.
[a] at critical probability of 0.5.

Table 6.8. Supplement to Table 6.4. Intercepts and dummies for time, regions and industries in model (I)

Method	Probit		OLS	
Dependent variable	*Y*		*NS/TS*	
Dummies	Parameter	Std. error	Parameter	Std. error
Intercept	-1.47 **	0.621	3.81 E-3	0.103
Time dummy 1978	0.336 ***	0.119	-6.89 E-4	0.016
Time dummy 1986	0.329 ***	0.097	-3.93 E-4	0.015
Dummy EFTA	-0.698 ***	0.136	-0.072 ***	0.023
Dummy Nam	-0.286	0.185	-0.046 ***	0.012
Dummy Lam	0.852 ***	0.262	0.012	0.030
Industry dummy 1	-0.652 ***	0.226	3.92 E-3	0.043
Industry dummy 2	-0.791 ***	0.240	0.029	0.037
Industry dummy 3	-0.229	0.182	3.09 E-3	0.012
Industry dummy 4	-0.685 **	0.302	-0.022	0.034
Industry dummy 5	-0.259	0.240	0.023	0.021
Industry dummy 6	0.274	0.270	-7.20 E-3	0.013
Industry dummy 7	-0.690 **	0.349	-0.025	0.032
Industry dummy 8	1.69 ***	0.285	0.059	0.048
Industry dummy 9	-0.141	0.254	0.045 **	0.023
Industry dummy 10	-0.812 ***	0.268	-0.056	0.032
Industry dummy 11	-0.423	0.270	-0.043	0.026
Industry dummy 12	-0.072	0.240	4.81 E-3	0.015
Industry dummy 13	1.02 ***	0.391	0.057	0.035
Industry dummy 14	0.608 **	0.248	0.024	0.023
Industry dummy 15	0.039	0.259	4.79 E-3	0.017
Industry dummy 16	-2.33 ***	0.470	-0.077	0.088
Industry dummy 17	-0.372 **	0.259	-7.03 E-3	0.021
Industry dummy 18	-0.364	0.308	0.041	0.053
Industry dummy 19	0.257	0.243	7.87 E-3	0.015
Industry dummy 20	-0.347	0.534	0.203 ***	0.051
Industry dummy 21	-0.550	0.366	0.087 ***	0.027

Note: ***, ** and * indicate significance at 1, 5 and 10 percent, respectively. The Ec is the reference group foı the region dummies and 1990 is the reference period.

Table 6. 9. Supplement to Table 6.4. Intercepts and dummies for time, regions and firms in model (II)

Method	Probit		OLS	
Dependent variable	*Y*		*NS/TS*	
Dummies	Parameter	Std. error	Parameter	Std. error
Intercept	-1.53 **	0.647	0.114	0.083
Time dummy 1978	0.438 ***	0.122	-0.015	0.013
Time dummy 1986	0.283 ***	0.108	-0.018 *	0.011
Dummy EFTA	-0.737 ***	0.140	-0.070 ***	0.017
Dummy Nam	-0.322 *	0.192	-0.041 ***	0.011
Dummy Lam	0.909 ***	0.270	2.72 E-3	0.024
Firm dummy 1	1.39 ***	0.272	0.034	0.035
Firm dummy 2	1.05 ***	0.227	0.030	0.025
Firm dummy 3	0.879 ***	0.249	7.60 E-4	0.023
Firm dummy 4	-1.94 ***	0.496	-0.015	0.049
Firm dummy 5	0.342	0.213	2.40 E-3	0.020
Firm dummy 6	2.23 ***	0.269	0.038	0.048
Firm dummy 7	0.362 *	0.206	0.017	0.018
Firm dummy 8	1.37 ***	0.286	0.028	0.038
Firm dummy 9	0.014	0.258	-0.039 **	0.016
Firm dummy 10	-0.171	0.282	-0.045 *	0.028
Firm dummy 11	-0.486	0.323	-7.01 E-3	0.019
Firm dummy 12	-2.65 ***	0.474	-0.042	0.073
Firm dummy 13	-0.870 **	0.344	-0.062 **	0.029
Firm dummy 14	1.37 ***	0.232	0.030	0.030
Firm dummy 15	0.113	0.281	-0.025	0.022
Firm dummy 16	0.914 ***	0.316	0.021	0.031
Firm dummy 17	0.518 *	0.301	0.077 ***	0.025
Firm dummy 18	-0.217	0.383	-0.040 *	0.022
Firm dummy 19	-0.184	0.261	-0.033 ***	0.012
Firm dummy 20	0.280	0.280	-0.071 ***	0.023
Firm dummy 21	-0.117	0.326	-0.073 ***	0.022
Firm dummy 22	0.345	0.377	0.081 **	0.033
Firm dummy 23	0.132	0.296	-0.017	0.019
Firm dummy 24	0.849 **	0.402	-0.019	0.033
Firm dummy 25	0.261	0.340	1.85 E-3	0.033
Firm dummy 26	-1.01	0.723	0.449 ***	0.041
Firm dummy 27	-1.10 ***	0.366	-0.037	0.089

Note: ***, ** and * indicate significance at 1, 5 and 10 percent, respectively. The EC is the reference group for the region dummies and 1990 is the reference period.

CHAPTER 7

7. Conclusion

7.1 Introduction

The main objective of this thesis has been to shed light on the role of knowledge accumulation, size and network production on firm performance in perspective of the increased internationalization and technological progress that have characterized the last decades. To achieve this end, a number of empirical studies have been conducted, analyzing different aspects of these issues with focus on firms' profitability and international competitiveness. In addition, we have also presented, and applied, a methodology to identify industrial clusters and, finally, examined how the prevalence of a support system of large and small firms in a region affect the locational decisions of large firms. Below we will briefly - since the introduction contained a summary of the main results - recapitulate some of the findings and also discuss avenues for future research and the policy implications of the analysis. Even though the above analysis has been undertaken on data primarily referring to Sweden, we believe that he results can be generalized to other countries and regions as well.

We commenced by giving an overview of the Swedish SME-sector and the major trends that has characterized SMEs internationally as well as in Sweden. We found that in most countries there has been a trendwise shift in production towards smaller firms, however, this shift seems to be less notable in Sweden. In addition to this general picture, we also presented detailed a data set of Swedish firms, containing information on the stock of knowledge within the firms. These stocks include investments in marketing and education. The data set was then used in some of the empirical analyses in the following chapters.

In the chapter that follow (Chapter 3), the relationship between knowledge capital, size and profitability was investigated. The concept of knowledge, and the measure problems associated with knowledge factors, was first discussed. From the empirical analyses we concluded that firms' knowledge endowment was positively connected to the rate of profitability, however, no such impact was found of size on profitability.

In the subsequent chapter (Chapter 4), we commenced by testing whether sunk costs in firm-specific knowledge assets was increasing in firm size. According to one strand of the literature, sunk costs is endogenous in market size. That suggests that firms producing similar products can be expected to have approximately the same relative sunk cost in knowledge assets, measured for instance as knowledge asset per employee. A weak positive relationship was also found to exist between size and relative knowledge endowments, albeit at a decreasing rate. Thus, the implemented data set, tended to reject the endogeniety hypothesis. Still, the relationship between knowledge assets and firm size indicates that after a certain level of knowledge accumulation was reached, diseconomies of scale in handling knowledge appear. This is likely to be related to the special character of knowledge, making it even harder to monitor, and exploit, than many other assets within the firm. This result is important since it validate the assumption of decreasing return to knowledge investment on the firm level which is often made in, for instance, growth theory. Furthermore, the accumulation of knowledge appeared as a prerequisite for gaining international competitiveness, measured as export intensity. In this case, size also plays a much more important role. In other words, larger firms have a higher propensity to export a larger part of their production, reflecting some kind of economies of scale. Taken together, we conclude that even though the accumulation of knowledge is a crucial determinant of firms' internationalization and profitability, firms of different size have different abilities and perform different tasks in industrial production.

We then carried on by presenting a methodology to identify clusters (Chapter 5), based on two main criteria: the intensity in interaction with other industries, and the geographical density of production. The methodology was then applied to Sweden and Ohio, a state in the U.S. of similar size and structure as Sweden. Moreover, to examine whether network factors influences the locational decisions of large firms, we analyzed whether regions, or countries, that are dense in similar production as the investing firm, were preferred investment locational sites (Chapter 6). Controlling for market size, exports, factor endowments, and a number of firm specific variables, the results did indeed indicate such a positive relationship. However, it was confined to a sector categorized as "high-tech", where the categorization was based on R&D-intensity. Hence, a prevalence of similar production seems to increase the attractiveness of a region for "high-tech" production. We interpreted this as related to the fact that the investing firm then have access o suppliers of goods and skills, i.e. a network, which is essential for its production. Hence, both input-output linkages and knowledge spillovers influence the locational pattern of large firms.

7.2 Policy implications and future research

From a policy perspective, the applied microeconomic analysis conducted in this thesis stresses the importance of knowledge. First, a higher endowment of knowledge was shown to have a positive impact on profitability. If we believe that higher profitability leads to more investment and production of goods with a high value-added content, then the welfare implications are quite obvious. Production of goods with high value-added increases demand for skilled, often well-paid, labor. It was also demonstrated in the above analysis that the prime source of firms' knowledge endowment was the composition of their labor force. Second, we concluded that international competitiveness increases in larger knowledge endowments and knowledge intensive firms tend to direct investments to regions and countries that have much of similar production. This suggests that economic policy must be geared to sustain and improve a country's knowledge base. This means that the education system must meet the requirements of international standards and that university research must be internationally competitive. But it also suggests that the institutions of a country must be designed such that interactions and communication (bridging) is allowed and stimulated between firms, small and large, service and manufacturing industries, universities and firms, etc. That has implications for the regulations of start-ups of firms, proprietary rules, labor markets, openness, and a whole range of areas related to the overall institutional setting in a country. If a country fails in this respect, it may find that investments - particularly of large firms - are concentrated to other regions and countries, where agglomeration forces may after a while further increase the attractiveness of such regions. In the longer run this may show up in divergent growth rates across regions and countries, with severe welfare effects.

An important field for future research is to more closely identify the mechanism behind such agglomeration economies, and the dynamics taken place in these cluster. Several studies point at the increased role for SMEs in R&D, where large firms have begun to outsource such activities that used to be considered as strategically important to preserve within the firm. As the barrier to trade and investment continues, parallelled by falling trade costs, we can expect the forces behind agglomeration or clustering to increase in the future.

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Pontus Braunerhjelm

Knowledge Capital, Firm Performance and Network Production

This book consists of a series of essays sharing the common feature that they all relate to recently advanced issues in empirical industrial organization. To what extent does knowledge influence firm performance? What is the characteristics of spatial concentration and how should it be measured? How does knowledge linkages and networks externalities, influence the international distribution of investments? These are some of the issues examined in this book. In addition, the book contains a description of the size distribution of firms across countries and over time. Moreover, data on the knowledge content and degree of internationalization distributed at different size categories are also presented.

The empirical analyses are all based on unique data sets, mainly collected by the Research Institute of Industrial Economics (IUI). In some of the analyses, firm data are pooled with data on country or industry level. The results of the empirical analyses suggest an increased importance of knowledge factors in explaining firm performance and internationalization. Furthermore, networks, or clusters, are shown to have become of interesting importance in terms of location of production.

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