FOREIGN ACTIVITIES OF SWEDISH MULTINATIONAL CORPORATIONS

Roger Svensson

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Foreword

In recent decades, foreign direct investment has increased significantly and has affected the home countries as well as the host countries of the multinational corporations (MNCs) with respect to production structure, trade, technology and growth. The Industrial Institute for Economic and Social Research (IUI) has a long tradition of studying international investment and trade flows and the institute has updated a data base on Swedish MNCs about every fourth year since 1965.

This study is part of a larger project on the internationalization of the Swedish industry. In the four empirical essays about Swedish MNCs in this volume, Roger Svensson analyzes the choice of entry mode, the location of overseas production, the effects of foreign production on parent exports and the extent to which foreign operations are necessary to finance technology creation within the firm.

The study is novel in two respects. First, some economic aspects of MNCs are tested empirically here for the first time. For example, the MNCs' previous patterns of foreign production and trade as determinants of entry mode and location of production are studied. The study also examines which host country factors attract MNCs. Special attention is paid to agglomeration patterns. The second novelty is of an econometric nature. New sample selections are introduced where also countries in which the firm has no affiliate production are included in the sample, not only those where production takes place. This type of empirical model requires that other econometric methods than those usually applied are used.

This book has been submitted as a doctoral thesis at Uppsala University. It is the 51st doctoral or licentiate dissertation completed at IUI since its foundation in 1939. IUI would like to thank the thesis advisor, Professor Anders Klevmarken at Uppsala University, for his encouragement and guidance.

Stockholm in March 1996

Ulf Jakobsson
Director of IUI

ABSTRACT

This dissertation examines some issues related to multinational corporations (MNCs). All studies are based on a unique data set of individual Swedish MNCs collected over many years by the Industrial Institute for Economic and Social Research (IUI) in Stockholm.

Chapter I discusses the relevancy of the studies included in the thesis and puts them into perspective by relating them to the previous literature. A brief summary of the thesis is also presented.

The choice between takeovers and greenfields in foreign direct investment is analyzed in Chapter II. In contrast to earlier studies, which assume that greenfields are more risky than takeovers, the starting point here is that MNCs operate on oligopolistic markets and that greenfields add production capacity to the industry. The results show that previous presence in the market increases the probability of takeovers, since a new venture would increase the competitive pressure on the investing firm's existing manufacturing affiliates. A new empirical model is introduced in which the firm has the alternative to refrain from investment altogether.

Chapter III examines the influence of host country characteristics on the location of foreign production. Particular attention is directed towards agglomeration tendencies in the location of firms. The sample selection incorporates countries where firms have decided not to establish affiliate production, which is an extension in comparison with previous research in this area. The results suggest that agglomeration effects are present, predominantly in technologically advanced industries. It is also shown that market size, the supply of skilled labor and earlier export patterns, affect the location of overseas production.

The impact of overseas production on parent exports is studied in Chapter IV. Two methodological applications are introduced: 1) In order to avoid sample selection bias, the model also includes countries to which the firm exports, but where it has not yet established any affiliates; 2) The effect of affiliate exports to "third countries" is incorporated. The results indicate that increased foreign production both substitutes exports of finished goods and attracts intermediate goods from the parent. In contrast to previous studies, the net effect is negative, albeit significant only in the case of affiliate exports in the EC.

In Chapter V, the simultaneous relationship between R&D and foreign sales is analyzed. It is argued that this relationship should especially apply to MNCs based in small open economies due to the firms' heavy dependence on foreign markets. The only previous study addressing this issue used data on MNCs originating from the United States, a country with a large domestic market, and did not find evidence of the hypothesized simultaneous relation. The empirical results reported in the present study suggest a positive and significant impact in both directions.

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The thesis has been possible to complete thanks to IUI's detailed data base on multinational corporations. I am grateful to those who have collected and structured the data base over the years. I also wish to thank Ulf Jakobsson, present director, and Gunnar Eliasson, former director of IUI, for their encouragement and for creating a stimulating research environment at IUI. Jörgen Nilson helped me with computer and software problems. The comments from the seminar participants at IUI and Uppsala University were also very helpful. Financial support from the Tore Browaldh Foundation is gratefully acknowledged. Finally, I would like to thank Cindy Miller for her competent work on my English.

Stockholm in January 1996

Roger Svensson

Chapter I

Introduction and Summary

Foreign direct investment (FDI), through which multinational corporations (MNCs) own and control manufacturing units in foreign countries, has evolved into a major force in the world economy in the last two decades. The annual growth of FDI averaged 30 percent in the late 1980s. Furthermore, sales by foreign manufacturing affiliates exceed by far the value of all international trade, and almost 30 percent of world trade is reported to occur within MNCs. It is true that there have also been massive flows of portfolio investments on financial markets, but FDI should be more important for national economies. The reason is that FDI involves not only financial flows but also transfers of intangible assets, e.g. knowledge in the form of technology, production processes, distribution channels and management.

The theoretical advances recently achieved in the area of MNCs and international trade have not been matched by empirical studies on the determinants of entry modes and the location of affiliates abroad. For instance, in one field of the theoretical literature it is argued that firms within an industry tend to concentrate in geographically well-defined areas, referred to as agglomeration patterns, but there is less convincing evidence that this is empirically true. A related research question concerns the interaction between the creation of firm-specific advantages within the MNCs and their internationalization. Are large market shares abroad necessary to finance large fixed costs such as R&D and marketing?

The aim of this dissertation is to empirically analyze some issues related to MNCs and their activities. The thesis consists of four separate studies which in given order examine: a) the determinants of the choice of entry mode in FDI (chapter II); b) if agglomeration factors in the host country affect the location of overseas production (chapter III); c) the impact of foreign production on home country exports (chapter IV); and d) the simultaneous relationship between R&D and foreign sales (chapter V).

Existing empirical literature on MNCs has primarily been concerned with firms originating in the world's largest economies. This thesis implements a unique database on individual MNCs based in Sweden, a small open economy. Seldom has such detailed data been applied in this area of economics, most previous work has relied on industry data or even information aggregated on the country level. Swedish firms and their actions differ from firms originating in large countries in two main ways: a) the small domestic market has forced Swedish firms to go abroad at a relatively early stage of their lifecycle in order to cover fixed costs required for e.g. marketing and R&D; b) large firms tend to play a relatively important role in small economies, e.g. in terms of employment, trade and product innovation. Many of the skills and intangible assets of the manufacturing sector can be found in these firms, and their moves will not always be counterbalanced by the actions of other firms. Small economies will therefore be strongly affected by the location decisions of these firms.

In the first section of this chapter, I present the research area of the themes analyzed in the thesis. The sample selections and methods used in previous studies are discussed in section 2. Section 3 provides a short description of the database and the last section is a brief summary of the thesis.

1. Basic themes

1.1 Entry mode in FDI

When undertaking FDI, a firm can either acquire an existing firm or set up a new venture. The choice of entry mode has implications both for the host country in terms of employment and competition, and for the investing MNC itself. Affiliates established through greenfield investments tend to be more integrated with the parent company than acquired affiliates. This means that, for example, technology transfers from the parent are primarily directed to the former group of affiliates.

The most frequently used starting point in previous work analyzing the entry mode in FDI is that of Caves (1982) where a takeover is assumed to be less risky than a greenfield investment, since it gives access to valuable information about the

host country market. This risk advantage in combination with competition among shareholders and potential entrants will raise the acquisition price and reduce the expected rate of return of a takeover. A large MNC with long experience and a diversified portfolio of foreign affiliates is more willing to take risks and would therefore use greenfield investment. Empirical studies have not verified this hypothesis (Kogut and Singh, 1988; Zejan 1990), however, and some studies have even found the opposite result (Caves and Mehra, 1986; Andersson and Svensson, 1994).

A counter-argument to Caves which is a possible explanation for the latter result is that a new venture can be tailor-made to fit the organization and assets of the investing firm. An acquisition, on the other hand, means taking advantage of already existing assets but having to adapt them to the interests of the parent company, which may create difficulties for small and unexperienced firms with less organizational capacity. In this sense, a takeover would be at least as risky as a greenfield investment.

According to the industrial organization literature, a new venture adds production capacity and increases the competitive pressure in the industry, while a takeover need not. Previous empirical studies have implemented explanatory variables both from this capacity-argument and from Caves' risk-argument above, though these theories partly contradict each other. For instance, consider a case where the firm already has an affiliate in the host country. An acquisition would then be preferable according to the capacity theorem, since a greenfield investment would hurt the investing firm's already existing affiliate. But according to Caves' theorem, a firm is more likely to set up a new venture. The firm would, instead, make a takeover the first time a host country is entered in order to acquire valuable information about the market. Thus, it is not appropriate to use these theories in the same model.

1.2 Locational patterns of overseas production

The previous empirical literature analyzing the country pattern of overseas production has focused on factors such as the size of the market, the degree of openness, market proximity and factor costs. Generally, market size and proximity

seem to attract FDIs, while the results are more scattered for openness and factor costs. For instance, Swedenborg (1979, 1982), using data on Swedish MNCs, concludes that a large market size and high wages in the host country attract FDI. She also found that high tariffs exert a positive influence on the locational decision. Kravis and Lipsey (1982), using U.S. data, and Veugelers (1991) conclude that the market size and geographical proximity have a positive impact on the distribution of investments. Furthermore, Kravis and Lipsey (1982) report a pattern of "opposite attract", i.e. firms in low wage industries invest in high wage markets. With respect to openness, Kravis and Lipsey (1982) and Culem (1988) suggest that openness has a positive influence on FDI, while Horst (1972) and Wheeler and Mody (1992) report the opposite result and Baldwin (1979) and Veugelers (1992) find no significant impact. Finally, Brainard (1993a,b) suggests that both trade barriers and transport costs exert a positive impact on the share of U.S. foreign affiliate sales in total foreign sales. She also concludes that factor costs have no influence on the locational pattern of FDI.

Recent locational theories have shown how firms in a specific industry may concentrate production in certain geographically well-defined areas, even though costs are higher. One reason for such agglomeration patterns is linked to the presence of intra-industry technological and information spillovers (Romer, 1986; Sala-i-Martin, 1990). Another explanation is that different demand and supply linkages, such as joint networks of suppliers and distributors or low transportation costs, lead to a concentration of production (Krugman 1991a,b; Venables, 1993). If agglomeration factors turn out to be important for the firms' location decisions, this could, according to the new growth theory, have effects 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.

Yet, few attempts have been made to empirically analyze agglomeration tendencies in FDI. One exception is the study by Wheeler and Mody (1992) where host country characteristics, such as the quality of the infrastructure, the degree of industrialization and the level of inward FDI into the respective market, are argued to represent agglomeration factors. Using U.S. industry data, they concluded that MNCs regard such factors as one of the main determinants of FDI. No study has

yet to analyze this issue on a more detailed level, asking, for example, if individual firms are attracted by agglomeration factors on the industry level in the host country.

1.3 Home country effects of foreign operations

Foreign activities enable a firm to operate more efficiently as a whole, but the impact on the home economy is still uncertain. Foreign production may be essential for a firm to remain competitive on the world market. The home country can be affected in numerous ways, e.g. in its employment, exports, investment, competition, and the consequences of these effects are not as obvious. In a small open economy like Sweden where the MNCs weigh relatively heavily with respect to employment and trade, the effects of foreign operations should be more significant than in large economies.

Although it is not possible to evaluate the welfare effects on the home economy when considering individual MNCs, some interesting aspects of trade, production flows and investment can be studied. There are two main ways to relate operations abroad with those at home for MNCs: a) by comparing foreign and domestic investments to each other. Several studies have suggested that substitution effects are prevalent. These findings have mainly been attributed to internal restrictions in the short run on the *supply side* faced by the firm in terms of limited access to financing, management and technology; b) the impact of host country production on parent exports from the home country, i.e. effects originating from the *demand side* of the firm. More precisely, commodity flows that are directed to the same market are related to each other.

In traditional theoretical models analyzing the latter issue (see Caves, 1982, for a survey), firms supply a foreign market either through affiliate production within the host country, by licensing production to another firm or by exporting from the home country. The firm's market share in the host country is assumed to be given in these models. Accordingly, production abroad simply replaces exports from the home country. As soon as this assumption of fixed market shares is relaxed, however, the effects become unsettled. Most empirical studies have indeed

suggested positive or insignificant effects, but only Swedenborg (1979, 1982) and Lipsey and Weiss (1984) have used firm level data. Some of these studies have methodological drawbacks, as we shall see below.

1.4 R&D, competitiveness and sales on foreign markets

It is generally accepted that firms exploit intangible assets in order to penetrate foreign markets. Such assets can take the form of marketing, human capital or, above all, technology. Technology is, however, seldom traded between firms since transaction costs are high for these assets. Some of the technology within a firm must therefore be created through R&D investments. Numerous empirical studies have supported the view that, in the end, R&D activities create competitive advantages and stimulate sales abroad as well as at home.

R&D investments are associated with large fixed costs. Large sales make it easier to spread these costs on the final products. In other words, the rate of return on each R&D dollar spent will be higher, the larger the output of the firm. Furthermore, more internal funds will be available which can be used to finance further R&D activities. In an economy with a small domestic market like Sweden, where firms' sales are already large and have limited possibilities for further expansion, firms have to go abroad in order to grow and attain a competitive scale. This means that foreign sales, and not total sales, should be related to R&D expenditures. The simultaneous relationship between R&D and foreign sales has only been investigated by Hirschey (1981) analyzing industry data for the U.S., a country with a large domestic market. His result did not support a two-way relationship, however.

2. Sample selection and methodology

Previous empirical work analyzing the location of MNCs' production abroad has neglected the decision of whether or not to locate manufacturing affiliates in a country. This is unfortunate, since that decision and the decision as to the level of operation to choose in the case of establishment are probably interrelated and

therefore likely to be made simultaneously. In general, earlier studies (e.g. Kravis and Lipsey, 1988; Wheeler and Mody, 1992) have restricted their samples to countries where production actually takes place. This means that the FDI decision is already given in these models and that they have only tested why firms produce more or less in already established affiliates. The alternative to choosing a high level of operation may, however, be to refrain from investment altogether. In order to avoid sample selection bias and to analyze both location decisions of the firm, countries hosting no affiliates should be included in the sample in order to compare these with countries where production is located.

When relating foreign production to exports from the parent company, previous studies using firm-level data (Swedenborg, 1979, 1982; Lipsey and Weiss, 1984) have also only considered markets where the firm has established production. But parent exports are directed to other countries as well, which means that part of the export flows has been ignored in the analysis. Even more important, the impact of affiliate exports to third countries on home country exports has never been examined. In the EC, about one third of the affiliate production of Swedish MNCs is exported to third countries, which means that this flow should not be neglected.

Traditional models analyzing the entry mode behavior in foreign markets have only considered the choice between two alternatives: takeovers and greenfields (Caves and Mehra, 1986; Zejan, 1990; Andersson and Svensson, 1994). This means that the decision to invest in the host country has been given also in this case. Yet, there exist other alternatives. For example, a firm may choose to refrain from investment or to invest in some other country. The alternative to setting up a new venture may, in fact, be to stay out entirely rather than make a takeover. A larger sample consisting of countries where the firm has not only made acquisitions or greenfield investments, but also decided against entry would take into account all possible binary choices between the three alternatives.

In line with the reasoning above, three of the four studies in this thesis extend the sample further than in the previous literature in order to avoid sample selection bias. Different kinds of methods incorporating a censored dependent variable are therefore used. For example, the independent logit, tobit, simultaneous

tobit or selection bias corrected regression methods.

3. The data

In all studies of this thesis, a unique data base on Swedish MNCs collected by IUI about every fourth year since the mid-1960s is used (1965, 1970, 1974, 1978, 1986 and 1990). With a response frequency of about 95 percent over the years, the data set covers virtually the whole population of Swedish MNCs in manufacturing. All firms with more than 50 employees and with at least one majority-owned foreign affiliate are included. Detailed information on the firm level and the affiliate level is available, including sales, investments and R&D as well as entry mode, exports and intra-firm imports of individual affiliates. This gives an opportunity to analyze issues which seldom can be examined using official statistics or industry data. In fact, no other database covers MNCs from a single country equally well across industries or over time.

In each survey, the sample consists of more than 100 MNCs with manufacturing units abroad. Between 400 and 750 manufacturing affiliates belong to these MNCs. For the last two surveys, there is another sample with about 200 MNCs with only foreign sales affiliates, but this group is excluded from the analysis due to the limited time series and the fact that it contains too few variables. Although firms with less than 50 employees, foreign-owned firms in Sweden or sectors other than manufacturing are not covered by the IUI survey, a comparison with official data shows that the MNCs included in the IUI survey correspond to at least 91 percent of total foreign employment in Swedish manufacturing firms and about 83 percent when all sectors are included.[1]

4. A summary of the thesis

Chapter II. The choice between takeovers and greenfields in FDI is examined. The starting point here is that MNCs operate on oligopolistic markets and a greenfield

[1] For more detailed information about the database and the collection see Chapter VI, or in the case of descriptive statistics see Andersson *et al.* (1996).

investment adds production capacity and lowers profits in the industry. Whether a greenfield is preferable over a takeover depends on the market growth and the investing firm's previous presence in the market. The size of the establishment in the case of a new production plant and the elasticity of industry demand are also hypothesized to be important.

Previous empirical studies analyzing the choice of entry mode have taken the investment decision in the host country as given. In this chapter, a new empirical model with a corresponding econometric method is introduced in which the firm has the alternative to refrain from investment altogether. A multinomial probit model would be best suited for such a model of the entry mode with three alternatives. Statistical tests suggest, however, that there is no problem in using a multinomial logit model if a large number of explanatory variables and dummies for industries and regions are included. In this situation, it is not an error to drop the no entry alternative, but the estimates would then be inefficient.

The empirical results strongly support the view that previous presence in the market favors takeovers, since a greenfield investment would increase the competitive pressure and hurt the investing firm's already established affiliates. It is also shown that, given the size of the industry in the host country, a large plant size on the part of the investing firm increases the probability of takeovers. The explanation is that a large establishment in the case of a new venture means a large impact on industry profits. Firms with a large optimal plant size would therefore have a stronger bargaining position and be able to lower the acquisition price of local firms. Furthermore, there is some evidence that high-tech firms prefer new ventures maybe due to compatibility problems with the production technology in the existing local firms.

Chapter III. The influence of host country characteristics on the location of overseas production is analyzed. Particular attention is directed to concentration in the location of production in specific industries, despite higher costs. Theoretically, there are two arguments for such agglomeration tendencies: a) intra-industry technological and information spillovers; b) demand and supply linkages, e.g. joint networks of suppliers and distributors, or low transportation costs. The OLI-theory

(Dunning, 1977) extended to account for agglomeration effects constitutes the theoretical framework in our model. The agglomeration factors are here represented by a variable measuring the relative size of the investing firm's industry in the host country.

In order to avoid sample selection bias, the sample includes countries where firms have decided not to establish affiliate production, which is an extension of previous research in this area. Estimation techniques having a censored dependent variable are therefore used. It is then possible to estimate the two locational decisions separately, i.e. the dichotomous decision of whether or not to locate production in a country and what level of operation to choose if an affiliate is established.

The statistical estimations suggest that agglomeration effects are present, predominantly in technologically advanced industries. Furthermore, agglomeration is especially important for the dichotomous decision of whether to be present in a market or not. It is also shown that earlier exports pattern of the firm, the market size, the supply of skilled labor in the host country and geographical proximity affect the location of overseas production. The statistical parameter estimates also differ with respect to the sign and significance for the dichotomous and marginal choice of location for some of the independent variables. This suggests that the two decisions should be estimated in a two-stage model.

Chapter IV. This chapter analyzes the impact of overseas production on home country exports, that is to say, how commodity flows on the demand side of the firm, which are directed to the same market, are related to each other. A simultaneous model is applied in order to take into account that the trade pattern of the firm partly determines the location of production. Two methodological novelties are introduced: a) export markets where the firm has no manufacturing units are also included in the sample. Previous studies have only considered countries where production actually takes place; b) the effect of affiliate exports on parent exports to third countries is incorporated.

Exports from the parent company are divided into intermediate and finished products. An increase in overseas production generates a positive or negative net

effect depending on whether the complementary effect on exports of intermediates outweighs the substitution effect on exports of finished products. On a theoretical basis, it is impossible to determine the outcome, which means that it has to be tested empirically. The net effect is, however, hypothesized to be less positive, or more negative, when the affiliate produces for exports rather than for local sales. The reason is that the transportation costs, as well as the costs of obtaining information about the market, are higher when the firm is not directly present on the market where it sells. The expansion in total sales due to a given increase in affiliate production should therefore be larger in the case of affiliate production for local sales, and, thus, the decline in parent exports should be lower.

The results indicate that increased foreign production substitutes for parent exports of finished products and attracts more intermediate products, which effect is statistically significant. In contrast to previous studies which have only found positive or no effects, the net effect here turns out to be negative. In the case of production for local sales the net effect is small and never significant. The negative net effect is, however, significant when the affiliate produces for exports. It is also shown that more foreign production: a) increases the firm's total sales in the host country; b) stimulates international trade flows, since the increase in affiliate exports is larger than the net decline in parent exports.

Chapter V. The simultaneous relationship between R&D and foreign sales is analyzed. It is argued that R&D investment is one of the factors that gives the firm a competitive advantage and promotes more sales in foreign markets. Large foreign operations in turn imply that the R&D-created knowledge will be utilized more extensively and that the rate of return on each R&D dollar spent should be higher. More internal funds will also be available to finance further R&D projects. Most previous studies have related R&D to total sales, but the relationship to foreign sales should especially apply to MNCs based in a small open economy like Sweden where the domestic market is of limited size.

The empirical results suggest that R&D investments increase sales in foreign markets and that sales abroad, in turn, make more resources available for further R&D investments. When analyzing product-related and process-related R&D

separately, R&D of both types influences foreign sales. The reinforcing effect is, however, not found for process-related R&D. One explanation may be that the large R&D investors primarily deal with product innovations and it is these firms which are dependent on foreign markets for financing R&D.

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Chapter II

The Choice of Entry Mode in Foreign Direct Investment

1. Introduction

When undertaking foreign direct investment (FDI) a firm can either acquire an existing firm, or perform a greenfield investment.[1] The choice of entry mode has several implications for the investing multinational corporation (MNC) as well as for the host country. Greenfield establishments are more inclined to import intermediates from the home country than are acquired firms. This indicates relatively large "embodied" technology transfers from parent companies to new ventures (Andersson *et al.*, 1996). Acquired firms, on the other hand, are characterized by their own corporate culture and connections with local subcontractors, and will not always be integrated with the parent. In this case, knowledge transfers may be going in either direction.[2]

A new venture is commonly expected to create more job opportunities in the host country than an acquisition, both directly in the new production plant and indirectly via subcontractors and sales networks. Acquiring an already existing firm sometimes incorporates the acquisition of the whole distribution chain.

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[1] The terms establishment and entry are used synonymously in this paper, and they do not necessarily mean entry for the first time in a country. Greenfield investment is here defined as the establishment of a new venture which is not based on a former domestic firm. It may be organized as the restructuring of a former sales affiliate belonging to the foreign MNC itself. Only majority-owned manufacturing affiliates are considered, i.e. affiliates over which the parent has full control. Note that both a takeover and a greenfield may be equivalent to a joint venture, if the affiliate is not owned to 100 percent.

[2] Undertaking acquisitions for the purpose of securing access to know-how is referred to as "technology-sourcing".

Furthermore, a greenfield investment adds a new manufacturing unit, meaning that the industry's capacity and competition are increased in the market.[3]

The present study examines the determinants of the choice of entry mode in FDI. Previous empirical studies that have analyzed this issue are based on the assumption that the decision to undertake FDI in the host country has already been made. The alternative to setting up a new venture, however, may be to refrain from investment altogether rather than to make a takeover. A profit-maximizing firm should also compare investment alternatives in different countries before choosing the investment with the highest expected rate of return. In the present study, a new empirical model is therefore introduced in which the two decisions of entry and entry mode are interrelated and made simultaneously.

The most frequently used theoretical basis of previous studies can be found in Caves (1982) where a takeover is associated with a lower risk than a greenfield, since acquiring a local firm gives access to a stock of customers and valuable information about the national market, e.g. in the form of management staff, already established distribution networks or manufacturing skills adapted to local conditions. This risk advantage in combination with competition among share-holders and potential entrants will raise the acquisition price and reduce the expected rate of return of a takeover. Large MNCs with long experience and diversified portfolios of foreign affiliates are more willing to take risks and thus would be more inclined to use greenfield investment.

Empirical studies have not verified this hypothesis. Kogut and Singh (1988) and Hennart and Park (1993) using data on Japanese entries in the United States, as well as Zejan (1990), studying Swedish MNCs, found no relationship between entry mode and the experience of the investing firm. Only Yamawaki (1994b), analyzing Japanese firms, has suggested that experience favor greenfields.[4] In contrast, Caves and Mehra (1986), studying foreign entries into the United States,

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[3] In the long run, however, it is more difficult to evaluate the effects on employment and competition in the host country.

[4] Caves (1982) claims that two studies by Dubin (1976) and Stopford (1976) have shown empirically that large firms with long experience prefer to enter by greenfields. The statistical tests or regression analyses are, however, either absent or of dubious quality in these studies, meaning that the evidence is rather weak.

and Andersson and Svensson (1994), using Swedish firms, found that large MNCs with long experience are more likely to enter by takeovers.[5]

One possible explanation for the latter result is that acquisition means not only taking advantage of already established assets but also having to adapt them to the interests of the parent company, which may create difficulties for smaller and less experienced firms. A new venture, on the other hand, can be tailor-made to fit the investing MNC's network of assets and relations. In this sense, takeovers would be more risky than greenfields. Andersson and Svensson (1994) suggest instead that the two entry modes require different abilities from the investing firm. Firms that are dependent upon skills based on owner-specific technologies are argued to favor greenfields, while firms that emphasize the ability to organize technologies in general or to harmonize assets in separate organizations should favor takeovers.[6] Other empirical observations indicate that primarily takeovers are sold off by MNCs (Yamawaki, 1994a), which may depend on that takeovers are associated with business failures to a higher degree and therefore are more risky than greenfields. Moreover, valuable information about the market can be obtained by other means than takeovers, e.g. by exporting to the market or by setting up sales affiliates. These objections together suggest that another theoretical starting point is needed than that of Caves (1982) above.

Another problem in previous studies is that the explanatory variables are derived from several different theorems, though these theorems may contradict each other. For instance, Caves and Mehra (1986) and Zejan (1990) concluded that MNCs that are diversified with respect to product lines prefer to use takeovers as an entry mode. In the former study, it is argued that: "The diversifying firm sets up an apparatus to make acquisitions, reducing the incremental cost of merger transactions, and it is likely to adopt a corporate organization congenial to managing a large numbers of relatively independent subsidiaries.". Hence, this

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[5] In Andersson *et al.* (1992), the correlation between takeovers, on the one hand, and firm size and experience of foreign markets, on the other hand, were 0.18 and 0.24, respectively, both significant at the 1%-level. In a logit model, the latter two variables had a positive and significant impact on the probability of takeover. The sample consisted of all establishment abroad by Swedish MNCs 1966-90.

[6] One problem in this study was how to measure "organizational skills". This factor was proxied by total sales of the firm.

diversification argument gives a result that is directly opposed to the one generated from Caves (1982) diversification argument mentioned above. At the same time, the Caves's argument is used as a theoretical starting point in these studies.

Although no theoretical model is derived in the present study, the main explanatory variables in the empirical model are related to the facts that MNCs operate on oligopolistic markets and that a new venture adds capacity in the industry, which in turn lowers product prices and profits. The larger the impact on profits, the stronger the bargaining position of the potential entrant and the lower the acquisition price of local firms ought to be. For example, if the optimal plant size of an investing firm is large, then a greenfield entry would have a large effect on industry capacity and profits, which speaks in favor of a takeover. It is further expected that previous presence in the market will favor takeovers, since a greenfield would hurt the investing firm's previous affiliate.[7]

The theoretical reasoning underlying the empirical model is discussed in section 2. Section 3 shows some different empirical models of the choice of entry mode. The data base and the econometric specification are described in section 4. The empirical results are presented in section 5, and the final section concludes.

2. Theoretical aspects of the entry mode

There are some differences between an international analysis of MNCs entering host countries through FDI and a national analysis of firms in general entering the local domestic market. Though entry always is associated with some costs due to e.g. setting up distribution channels, subcontractors, the MNC must also overcome geographical and cultural barriers as well as additional costs of information and knowledge about the specific local market when establishing manufacturing affiliates

[7] Earlier studies (e.g. Caves and Mehra, 1986; Hennart and Park, 1993) have also included variables related to this capacity theorem. Such variables have, however, been mixed with variables derived from other theories, although the different theories partly contradict each other. For instance, previous presence in the market should, according to Caves's (1982) theorem above, already have given necessary information about the local market. Risky greenfields should therefore be favored. This is the opposite result to the capacity-theorem. Thus, there are not only empirical reasons as mentioned above, but also theoretical arguments, for not using variables related to Caves's theorem in the present study.

abroad. Firm-specific assets in the form of technology, human capital, product differentiation, etc., are therefore required to overcome these costs. Since markets for such "intangible assets" hardly exist or are imperfect, it is easier to internalize these assets within the firm rather than to sell them to competitors. Another characteristic of the international perspective is that the MNC has several markets to invest in. If the resources of the investing firm are scarce, no establishment in one country may imply investment in another country, i.e. the investment decisions in different countries may be interdependent. Furthermore, the MNC can always choose to export to the market rather than establishing an affiliate.

One of the most specific characteristics of MNCs is that they operate on both oligopolistic local markets and world markets.[8] In each host country there is a limited number of firms, each of which is large enough to face a downward sloping demand curve. A natural framework for a theoretical discussion of the entry and entry mode decision is therefore the Cournot model.[9] One important factor in the choice of entry mode is the acquisition price of local firms. This price is determined endogenously by the conditions in the market, but it can only partly be discriminated by the different potential entrants. The acquisition price of a local firm would adjust fully to the characteristics of the investing firm, if and only if one of the actors has the whole bargaining power, which seems unreasonable to believe.[10]

When a firm decides whether to enter a market or not, and if so, which entry mode to use, it will choose the alternative that has the highest expected rate of return at the same time the risk of the investment is considered. The ranking of the alternatives, greenfield, takeover, or no entry, is here assumed to be dependent on the following three main groups of factors: i) Factors related to oligopolistic

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[8] Already Hymer (1960) argued that the existence of MNCs is inconsistent with perfect competition. The observation of MNCs is then a sufficient condition that the market is characterized by oligopoly.

[9] In a context where capacity investments are long run decisions there may be reason to believe that the market is better described by a quantity competition than price competition model. For a discussion see Kreps and Schenkman (1983).

[10] If a seller tries to apply total price discrimination and two potential entrants have to pay different acquisition prices for a given local firm, then there would be incentives for these entrants to trade with each other.

markets with the starting point that a new venture adds production capacity to the market, while a takeover does not; ii) The availability of suitable acquisition targets; iii) Factors which affect the entry decision but may leave the choice of entry mode uninfluenced.

2.1. Factors related to oligopolistic markets

A greenfield investment increases production capacity in the market which in turn makes a Cournot type market more competitive.[11] Given the incumbent firms' quantities (strategies), total output in the industry increases, i.e. the supply curve shifts to the right, causing the market price of the products to decrease, which means that profits shrink. This poses a potential threat to the market from the entrant. Market conditions and characteristics of the investing firm are supposed to determine whether an output expansion is more or less favorable than an acquisition. The incumbent firms' reactions to a greenfield investment may also influence the entry mode choice of the investing firm. The effects of these reactions can, however, be very difficult to evaluate.

If the foreign affiliate is established for the purpose of exporting to a third market, the below arguments related to oligopolistic markets will be weaker. Such affiliates would, in principle, face an infinitely elastic demand curve if the third market is large enough. It is also possible for the potential entrant to increase exports to the market, e.g. from the home country, which would have almost the same implications on industry capacity as the establishment of a new venture. One could regard the third alternative to refrain from investment, as a choice to *increase* exports to the market. The alternatives greenfield and no entry would, however, be similar if and only if the increase in capacity is equal in each case. On the other hand, no entry may imply that nothing has been changed, i.e. the firm exports the same amount as before to the market. From the firm's point of view, a greenfield investment saves costs associated with tariffs and transportation, which means that

[11] The firm can also increase capacity in given affiliates, which would lower product prices and profits in the industry. If each affiliate has some optimal level of scale, however, the adjustment in output is limited for a given affiliate. Output expansion above some critical value must then be accomplished by the establishment of a new venture.

an expansion in exports may not be an available, or sufficient, alternative.

Previous affiliates. If the firm already has a manufacturing subsidiary in the market a greenfield investment, which adds industry capacity, would hurt the firm's already existing subsidiary. Additional affiliates are therefore relatively more likely to be established through takeovers in order to reduce the competitive pressure. The threat of establishing a new venture is, however, still credible as long as this would generate a profit, implying that the seller of an existing firm would not have the whole bargaining power. Having previous affiliates also means that fixed costs - such as marketing, distribution channels or contracts with subcontractors - associated with these production plants can be shared as more affiliates are established in the same market, either in the form of new ventures or acquired local firms which are integrated with the other parts of the MNC in the host country.[12] Due to the gain in fixed costs, takeovers should be more attractive than refraining from investment when the firm already has affiliates in the market, as compared to the case when it has no affiliates. How the odds between greenfield and no establishment are affected depends on whether the gain in utilizing already fixed investments is larger or smaller than the damage on the previous affiliate. The effect of previous presence in the market has earlier only been analyzed in Andersson and Svensson (1994), where it was found to favor takeovers.

Market growth. A high growth of market demand in the host country gives higher sales and profits in the future, making incumbent firms more valuable. Competition among potential entrants will then raise the acquisition prices of the existing firms, since it is more valuable to be present in such a market. The market growth will indeed make firms indifferent between takeover and no establishment if there is a full adjustment in acquisition prices. There will also be more space for greenfield investments in markets with high growth. Thus, a new venture will be more profitable than an acquisition or no investment in such markets. The growth factor has got support in some previous studies analyzing the choice of entry mode (Zejan,

[12] If the acquired affiliate is not integrated with the other parts of the MNC, then it will be difficult to utilize the fixed investments taken in previous affiliates.

1990; Andersson and Svensson, 1994; Yamawaki, 1994b).[13]

Optimal plant size. The size of the potential new production plant reflects the size of the impact on the industry capacity. At the time of entry, the acquired affiliate will, of course, be larger than the new venture, since it takes time for a new production plant to grow. One can imagine, however, that there is some optimal plant size for the firm due to technological factors or indivisibilities in production, meaning that the size of the affiliate will be independent of the entry mode some years after the establishment.[14] Given the size of the market, a new venture established by a firm with a large optimal plant size will give a large impact on industry capacity and profits. Such a firm would pose a larger threat and have a stronger bargaining position when making an acquisition than a firm with a small optimal plant size. As long as the threat of establishing a new venture is credible, the acquisition prices should be lower, the larger the optimal affiliate size of the investing firm, suggesting that a takeover is favored over a greenfield. The optimal plant size of the investing firm has not been properly tested in previous studies.[15]

A large plant size also indicates that the minimum capital requirement for entering the industry is large. This can be seen as a barrier to entry which limits competition. Existing MNCs which already have affiliates should therefore be favored. Such firms could then get a larger space to manoeuvre to increase or decrease quantities, i.e. to enter and exit different local markets, irrespective of entry mode.

Steepness of industry demand curve. The more inelastic the demand curve of the industry, the larger the impact on industry capacity and profits when a new

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[13] Some previous studies (cf. Caves, 1982) have also related a high growth to the need to act quickly in order not to forego potential gains, i.e. takeovers should be preferred. The need of rapid establishment may, however, have other explanations as well, e.g. the threat of tariffs or the time limit for the firm to utilize a patent.

[14] It could also be argued that this factor is partly industry specific.

[15] Caves and Mehra (1986) included a variable measuring the initial size of the investment. They argued that acquisitions are preferred when the desired scale of entry is large. In this case, it is more probable that the causal relationship is going in the opposite direction, i.e. the *initial* size of the affiliate is determined by the entry mode.

manufacturing unit is established. A steep demand curve will give potential entrants a stronger bargaining position and lower the acquisition prices of local firms. Thus, takeovers should be facilitated in markets with inelastic industry demand.

2.2. Factors related to the availability of suitable acquisition targets

The factors below related to the possibility of finding suitable firms to acquire do not need to affect the acquisition price of local firms. These factors have been included in previous empirical studies.

Technological specialization. Hennart and Park (1993) and Andersson and Svensson (1994) found that firms with high R&D intensities prefer to set up new ventures when undertaking FDI. In the latter study, it was argued that high-tech firms are more dependent on their own technology creation and production technology, and are therefore more likely to enter by greenfield investment. Another explanation for this phenomenon was developed in Fölster and Nyberg (1994), where a high technological level of the investing firm was argued to create compatibility problems with the production technology of the existing local firms. The difficulty to combine the investing firm's assets with those of local firms should therefore make takeovers less favorable than greenfields for high-tech firms. Both these explanations are maintained in the present study.[16]

High technological specialization - a form of intangible asset - means also that the firm possesses a competitive advantage over other firms, which should facilitate establishments abroad. It therefore seems reasonable that problems with technological compatibility and the cost advantage will make establishment by greenfield the most attractive alternative for a high-tech firm. Whether a high technology favors takeovers relative to no entry depends on whether the cost advantage is larger or smaller than the difficulties with technological compatibility.

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[16] Yamawaki (1994b) found that Japanese firms that do not have technological advantages are more likely to enter through acquisitions. His interpretation was that such firms use takeovers in order to acquire technology which they can not create themselves. It was, however, never verified whether the acquired local firms had a high or low technology.

Development level. In a highly developed country, there are *relatively* many local high quality firms. It is much more difficult to find suitable firms to acquire in less developed countries, causing the acquisition prices of such firms to increase. This suggests that greenfields should be preferred to takeovers in less developed countries. For the choice between entry and no entry, high development also means high incomes and labor costs. Unless high labor costs reflect high productivity, firms would choose to enter less developed countries. Labor costs and other factor costs have, however, received weak support in previous studies (cf. Brainard, 1993a). On the other hand, it is easy to find subcontractors, distribution channels and cooperation with other firms in developed countries, which means that FDI should be encouraged. The impact of the development level on the entry decision is therefore ambiguous.

Legal restrictions on takeovers and other factors. Restrictions on foreign ownership and acquisitions will reduce the possibility to establish or acquire subsidiaries in a country. Such factors are, for instance, dual classes of voting stocks, restrictions on foreign ownership of shares or different forms of networks and "syndicates" (Japan), but also financial factors. The function of the stock market will, of course, also influence the possibility to acquire local firms. Finally, establishing a new firm takes more time than buying an already existing one. The greater the need, on the part of the investing firm, for rapid establishment in the host country, the more attractive takeover becomes as mode of entry.

2.3. Factors influencing the entry decision

Earlier studies have found a lot of factors determining whether a firm will establish production in a country or not. Both firm- and country-specific characteristics from the previous literature are considered here, but they need not influence the entry mode decision.

Intangible assets. In addition to technological specialization mentioned above, a number of characteristics of the investing firm, representing intangible assets, may

create advantages over competitors, e.g. product differentiation, marketing organization or human capital. Establishment of foreign affiliates should therefore be easier for firms possessing such assets.

Market size. Almost all previous studies analyzing the location of production have found that large markets attract FDI (Caves, 1982). The explanation is that a large market means large demand for the firm's products, but also that such a market enables the firm to obtain economies of scale on the plant level.[17]

Distance. A large geographical or cultural distance between the host and home country should deter establishments, since lack of information makes it difficult to do business. It is true that establishments should be more favorable relative to exports to the market as shipments over long distances are costly, but this does not make such markets more attractive for production in an absolute perspective.

Openness. Protection in the form of high tariffs or import quotas makes it costly or even impossible to export to the market, which should encourage tariff-jumping FDI. This has been shown empirically by Wheeler and Mody (1992) and Brainard (1993b), but it is not theoretically unambiguous that low openness must favor FDI. The new locational theory, for instance, argues that high openness makes markets more accessible and thereby more attractive for establishments.

Other factors. Large endowments of natural resources, skilled labor and other crucial factors of production will make a country more attractive for establishments. Another factor is the exchange rate. If the currency of the host country is undervalued, establishments will be cheaper to perform, irrespective of entry mode (Aliber, 1970). The low exchange rate will also create a comparative advantage in production, especially if inputs are purchased in the local market and finished products are exported. One could, however, expect that fluctuations in the exchange

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[17] It could be argued that greenfields are favored in small countries where there are few acquisition targets. This reasoning does not hold, however, since small countries have also little space for more capacity.

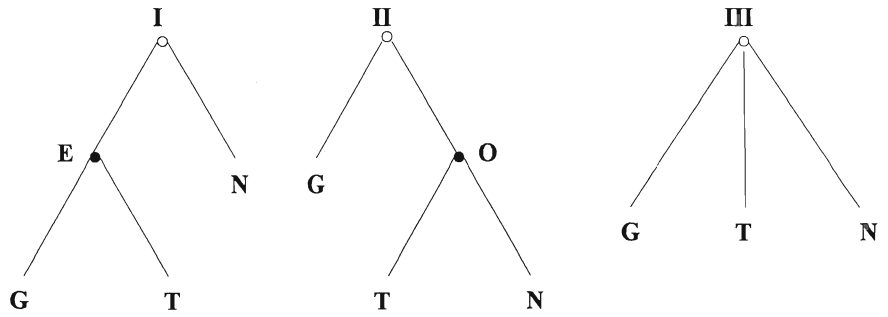
rate primarily affect portfolio investments while the location of FDI is determined by more long-term factors. Establishments should also be influenced by tax differences, although most previous studies have frequently neglected this factor.

3. Three empirical models of the choice of entry mode

Consider a potential entrant deciding whether to establish a manufacturing affiliate in a specific country. The firm must decide both if and how to enter. The models below show three possible decision rules, I, II and III, for the firm establishing an affiliate in a host country.

Model I. The entry decision is treated as predetermined and thus separable from the entry mode decision. Implicitly, this model has been used in most empirical studies analyzing the determinants of entry mode in different locations for MNCs, see e.g. Zejan (1990) and Andersson and Svensson (1994). In both of these studies the analysis focused on the second step which was evaluated econometrically by means of logit/probit methods. Studies analyzing entry mode in specific markets have also taken the entry decision as given, e.g. Caves and Mehra (1986), Hennart and Park (1993) and Yamawaki (1994b).

Figure 1. Three different models of the entry mode choice.



G = Greenfield E = Entry
T = Takeover O = No increase of capacity
N = No entry

Model II. The firm decides first whether to increase capacity in the host country, i.e whether to make a greenfield investment. If no capacity is added, then the firm can choose between a takeover or no entry. As in model I the decision problem is here assumed to be solved sequentially.

Model III. The decisions of entry and entry mode are made simultaneously. Thus there are three alternatives: (1) entry by greenfield or (2) by takeover, or (3) no establishment at all. This model presupposes that there are some joint determinants for the three alternatives.

Models II or III have never been considered in previous studies analyzing the choice of entry mode in FDI. While model II may seem rather far-fetched at first sight it is quite plausible if one believes that considerations about the capacity in the industry are taken into account when the greenfield alternative is compared to the other alternatives. Models I and II exclude each other and they are both special cases of model III.[18] In contrast to the other models, model III explicitly recognizes that the alternative to setting up a greenfield may be to refrain from investment altogether rather than to acquire a local firm, but it also includes any bivariate choice between the three alternatives.

If one considers the no entry alternative in model I as the possibility to invest in another country, then it is clear that the only decision in the first step is that between two potential host countries. A profit-maximizing firm with limited resources would, however, compare investment projects in different locations before choosing the investment with the highest expected rate of return at a given level of risk. This means that a greenfield investment in country A may be compared directly to a takeover of a local firm in country B, the alternative in each country being no entry at all. Both models I and II rule out this possibility, while model III is consistent with the behavior of such a firm. For these reasons, model III will be our main model in the empirical analysis.

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[18] Models I and II are associated with one more restriction compared to model III. In the former models, it is assumed that one alternative in the first step is independent of the other alternatives in the second step. This is not the case in model III.

4. The data base, econometric specification and explanatory variables

4.1. The data base and sample selection

The data base used in the empirical application has been collected by the Industrial Institute for Economic and Social Research in Stockholm about every fourth year since the mid-1960s (1965, 70, 74, 78, 86 and 90). It covers all Swedish MNCs in manufacturing and contains detailed information on each foreign majority-owned manufacturing affiliate, e.g. entry mode and year of establishment, as well as statistics on the firm level. Data for the exogenous variables on the country level are taken from the UN (1993) and on the country *and* industry level from the UN (1992), if not specified elsewhere.

In our main model III, the dependent variable, Y_{ijt}, shows if, and how, firm i has established manufacturing affiliates in country j during time period t.[19] It is qualitative in nature, taking on three different values: 0 if no entry was made; 1 if the firm entered through takeovers; 2 if greenfields were established. If the firm both made acquisitions and set up new ventures in a country during a certain time period, Y will take on the value of 1 or 2 depending on how the majority of the affiliates was established.[20] Each affiliate is included only once in the sample, i.e. when it joins a multinational group. This means that affiliates established 1971-74 are taken from the 1974 survey, establishments 1975-78 from the 1978 survey, etc.[21] There is always a possibility that an MNC will both establish *and* divest a certain affiliate during a given time period.[22] The probability that observations will be lost

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[19] The choice of the unit of observation, which is per firm, country and time period, stems from the fact that we know if an MNC has entered a country or not. In contrast, it is not possible to measure affiliates that have not been established, meaning that we can not use individual affiliates as the units of observation.

[20] If exactly 50 percent of the establishments were greenfields, Y is given the value of 2. This occurs only in a few cases in the sample, meaning that the results are not affected by this convention.

[21] The time periods used are 1962-65, 1966-70, 1971-74, 1975-78, 1979-86 and 1987-90. The length of the periods are determined by the time points when the surveys of the MNC data base have been collected.

[22] By divestment is here meant either the selling off, or the closing down, of an affiliate.

Table 1. The observations distributed over entry choices, across time periods.

Entry choice		1962-65	1966-70	1971-74	1975-78	1979-86	1987-90	All periods
Greenfield (G)		38	47	47	34	47	33	246
Takeover (T)		20	34	50	70	109	147	430
No entry (N)		1 299	1 759	2 065	2 242	1 937	2 419	11 721
All observations		1 357	1 840	2 162	2 346	2 093	2 599	12 397
Industries		1962-65	1966-70	1971-74	1975-78	1979-86	1987-90	All periods
Basic	G	8	14	6	4	4	2	38
	T	7	10	15	15	10	18	75
	N	238	275	370	349	216	187	1 635
	All	253	299	391	368	230	207	1 748
Chemicals	G	0	9	8	3	11	10	41
	T	2	4	5	5	24	25	65
	N	205	309	332	383	402	379	2 010
	All	207	322	345	391	437	414	2 116
Engineering	G	20	12	21	21	29	12	115
	T	10	14	22	33	66	77	222
	N	568	733	808	889	963	1 314	5 275
	All	598	759	851	943	1 058	1 403	5 612
Other	G	10	12	12	6	3	9	52
	T	1	6	8	17	9	27	68
	N	288	442	555	621	356	539	2 801
	All	299	460	575	644	368	575	2 921

in this way, or that the sample will be biased, is small, however, since on average only 2-3 years differ between the establishment and the time of observation.

The sample is based on the assumption that every firm considers all countries as potential investment locations. Accordingly, for each time period the number of observations is obtained by multiplying the number of firms by the number of countries considered.[23] As shown in Table 1, the sample has 12,397

[23] The sample includes the following 23 countries/markets: Germany, Belgium, the Netherlands, France, Italy, United Kingdom, Ireland, Denmark, Spain and Portugal from the EC; Norway, Finland, Switzerland and Austria from EFTA; North America comprises the United States and Canada; Latin America is divided into Mexico, Brazil and Argentina; Asia/Oceania includes four country-groups: Japan, ASEAN-countries (Singapore, Malaysia, Thailand, Indonesia, Philippines), India and Oceania (Australia, New Zealand). These are the countries where data for the explanatory variables are available on country and industry level. Although some countries are not included, this sample covers

observations. Of these 3.5 percent are takeovers and 2.0 percent are greenfields. The share of acquisitions in all establishments has increased over time in all industries,[24] and, although not shown in the table, also in all regions. Takeovers are more common in developed countries and especially in the EC, where the share has risen from 45 to 80 percent from the 1960s to the end of the 1980s. The corresponding figures for developing countries are 35 and 65 percent.

4.2. Econometric specification

The most suitable statistical model for model III is the non-ordered multinomial probit model. Unfortunately, this approach is associated with computational complexities since the maximization of the likelihood function involves the evaluation of multiple integrals, problems which are manifested by the fact that presently there exist no standard estimation algorithms for trinomial probit models. For this reason, a non-ordered multinomial logit model called "independent logit" has instead been estimated to predict the entry behavior of the firm (Amemiya, 1981; Fomby *et al.*, 1984). It is assumed that firm i chooses that alternative, $k=0$, 1, 2, which is associated with the highest expected payoff when risk is controlled in the form of country- and firm-specific factors.[25]

Suppressing indexes j and t to simplify the notation:

$$z_{ik} = x_i\beta_k + \epsilon_{ik} , \qquad (1)$$

where $\mathbf{x}_i$ is a vector of firm and host country characteristics. The vector of coefficients, β, shows the influence of the independent variables on the

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95 percent of all establishments 1962-90. Swedish MNCs have, for instance, almost never located investments in Africa or Middle East.

[24] The trend towards takeovers over time has also been noted by Caves and Mehra (1986) and Zejan (1990).

[25] It should be noted that this model does not directly compare investment alternatives in different countries with each other, as was discussed in section 3. The model is, however, *consistent* with such a behavior if one regards the no entry alternative as a possibility to invest in another country.

establishment choice, and is specific for each alternative k: β_0, β_1, and β_2.[26] The ϵ_{ik}'s represent the combined effects of unobserved random variables and random disturbances. The expected payoff for alternative k is given by $\mathbf{x}_i\beta_k$, while $\mathbf{z}_{ik}$ is a latent variable defined as the sum of $\mathbf{x}_i\beta_k$ and unobserved and random factors which also affect the firm's decision.

The ϵ_{ik}'s are assumed to be independently and identically distributed with Weibull density functions. In contrast to the multinomial probit method which permits the residuals to be correlated across the different alternatives, they are here assumed to be uncorrelated. The probabilities $P_i(k)=P(Y_i=k)$ are specified by:

$$P_i(2) = \frac{e^{x_i\beta_2}}{1 + e^{x_i\beta_1} + e^{x_i\beta_2}} \quad , \tag{2a}$$

$$P_i(1) = \frac{e^{x_i\beta_1}}{1 + e^{x_i\beta_1} + e^{x_i\beta_2}} \quad , \tag{2b}$$

$$P_i(0) = \frac{1}{1 + e^{x_i\beta_1} + e^{x_i\beta_2}} \quad , \tag{2c}$$

$$\textit{where} \sum_{k=0}^{2} P_i(k) = 1 \quad .$$

Here $\beta_0=0$, since if we know two probabilities, then the third is given. The three different odds of choosing one alternative relative another are then:

$$\frac{P_i(2)}{P_i(1)} = \frac{e^{x_i\beta_2}}{e^{x_i\beta_1}} = e^{x_i(\beta_2 - \beta_1)} \quad , \tag{3a}$$

$$\frac{P_i(2)}{P_i(0)} = e^{x_i\beta_2} \quad , \tag{3b}$$

$$\frac{P_i(1)}{P_i(0)} = e^{x_i\beta_1} \quad . \tag{3c}$$

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[26] In the original independent logit model the vector of explanatory variables is specific for each alternative k. Our explanatory variables vary across observations but not across alternatives, which means that: $\mathbf{x}_{i0} = \mathbf{x}_{i1} = \mathbf{x}_{i2} = \mathbf{x}_i$. The model must therefore be modified in the sense that the coefficient vector β is specific to each alternative k: β_0, β_1, and β_2 (Fomby *et al.*, 1984).

Hence, β_2-β_1 is the vector of parameters showing the impact of the independent variables on the choice between greenfields and takeovers.

A characteristic of the method used is that the odds ratio of a particular choice above is independent of other alternatives.[27] This property is termed "the independence of irrelevant alternatives" and follows from the initial assumption that the residuals are independent across different alternatives. We will test the validity of this assumption in accordance with Hausman and McFadden (1984). If a specific alternative is irrelevant, omitting it from the model will not change the parameter estimates systematically. The statistic is:

$$(\hat{\beta}_s - \hat{\beta}_f)' [\hat{V}_s - \hat{V}_f]^{-1} (\hat{\beta}_s - \hat{\beta}_f) \sim \chi^2_K \ , \qquad (4)$$

distributed as chi-squared with K (number of parameters) degrees of freedom. Subindex s indicates the estimators based on the restricted subset, f indicates the estimators based on the full set of choices, and $\mathbf{V}_s$ and $\mathbf{V}_f$ are the respective estimates of the asymptotic covariance matrixes. If the null hypothesis of independence of irrelevant alternatives can not be rejected, then it is possible to use the multinomial logit model. In this situation, a binomial logit model would also yield consistent estimates. Compared to the trinomial logit, the binomial logit estimates are inefficient, however. In practice, the test is performed by comparing the estimated parameters for e.g. the choice between G and T from the multinomial logit model with the estimates from a two-response logit model where the alternative N is omitted. The test will be applied for all three possible binary choices, i.e. G vs T, G vs N and T vs N.

4.3. Explanatory variables

The explanatory variables included in the model are either related to: i) oligopoly markets (*PA*, *MG*, *OPS* and *SI*), ii) the possibility to find suitable firms to acquire (*TS* and *DL*), or iii) factors influencing the entry choice (*LS*, *GDP*, *ESL*, *DIST* and

[27] This is normally a weakness if some of the alternatives are close substitutes to each other.

OPEN). Their expected impacts on the dependent variable are in accordance with the discussion in section 2, and they are defined as follows (cf. Table 2):

If firm i has a manufacturing affiliate in host country j at the beginning of time period t, the dummy variable PA_{ijt} takes the value of 1, and 0 otherwise. Previous presence increases the probability for takeovers relative to the other alternatives, but it is uncertain how it affects the odds between greenfields and no establishments. The market growth of the host country, MG_{bjt}, measured as the average annual growth of industrial production of industry b - in which firm i operates - in country j during time period t, is expected to have a positive influence on the probability of entry by greenfield.[28] The odds between takeover and no establishment should, however, not be affected. The optimal plant size of the investing firm, OPS_{it}, is measured as the average number of employees in firm i's foreign affiliates at the end of time period t, and is expected to favor takeovers over greenfields. This factor should also increase overall establishments compared to the alternative no entry. The number of employees in industry b - to which firm i belongs - in country j at the end of time period t, SI_{bjt}, measures the size of the industry. No hypotheses about the parameter signs are set up for *SI* since it is included only as a control variable for *OPS*.

The technological specialization of the investing firm, RD_{it}, is measured as firm i's total R&D expenditures divided by total sales at the end of time period t. *RD* is expected to favor greenfields, while the impact on the choice between takeovers and no establishments is uncertain. The development level of the host country, DL_{jt}, is defined as GDP per capita, and should have a positive impact on acquisitions compared to new ventures. The impact of *DL* on the establishment choice is, however, ambiguous.

Turning to the factors related to the location decision, all of them are expected to leave the choice between acquisitions and new ventures unaffected. Labor skill in the investing firm, *LS*, measured as the average wage in the home country part of firm i at the end of time period t, should represent an intangible asset and therefore facilitate establishments. Market size, GDP_{jt}, defined as GDP

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[28] In practice, this means that the annual average growth rate is mostly calculated for four years-periods in accordance with the length of the time periods t.

Table 2. Description of explanatory variables and their expected impact on the establishment choice.

Variable	Description	G vs T (β_2-β_1)	G vs N (β_2)	T vs N (β_1)
PA_{ij}	Dummy equal to 1 if the firm has previous affiliates in the host country, and 0 otherwise.	-	?	+
MG_{bj}	Market growth of the industry in the host country.	+	+	0
OPS_i	Optimal plant size of the investing firm.	-	+	+
SI_{bj}	Size of industry - to which the investing firm belongs - in the host country.	C	C	C
RD_i	Technological specialization of the firm (total R&D intensity).	+	+	?
DL_j	Development level of the host country.	-	?	?
LS_i	Labor skill of the investing firm.	0	+	+
GDP_j	Market size of the host country (GDP).	0	+	+
ESL_j	Endowment of skilled labor in the host country.	0	+	+
$DIST_j$	Distance between host and home countries.	0	-	-
$OPEN_j$	Openness of the host country.	0	-	-

Note: G=Greenfield, T=Takeover and N=No establishment. A '+' indicates an expected positive impact, a '-' a negative impact, a '?' an uncertain impact, a '0' no impact and a 'C' indicates a control variable.

of host country j at the end of time period t, and the endowment of skilled labor, ESL_{jt}, measured as the number of researchers, scientists, engineers and technicians per 1000s population in country j at the end of time t, are expected to attract FDI. Openness, $OPEN_j$, an index from Wheeler and Mody (1992), and distance between the home and host country, $DIST_j$, should deter investments.[29]

MG and *DL* vary more across time than across countries. For this reason, the

[29] *OPEN* takes on values from 1 to 10 where 10 means high openness. The index includes limits on foreign ownership as well as government requirements that a certain percentage of local components must be used in production. *DIST* takes both geographical and cultural/linguistic distance into account (Nordström, 1991).

explanatory power of these variables tends to disappear when different time trend variables are included. To reduce this multicollinearity problem, *MG* and *DL* have been divided by the corresponding cross-country means in each time period, making the cross-sectional impact of *MG* and *DL* more clean-cut.

One explanatory factor, the steepness of the demand curve, is omitted from the estimations due to lack of data. This need not bias the estimations, however, provided that the omitted demand variable is not correlated with the other explanatory variables.[30] There are also other factors affecting the choice of establishment, especially restrictions on takeovers or the desired speed of establishment. Empirical observations suggest that restrictions on takeovers have successively been made less binding over time in most countries. It is likely that the lifting of restrictions on acquisitions could explain a lot of the trend towards takeovers as was seen in Table 1, and also the fact that establishments are rare in certain countries.[31] Data on such factors are difficult to collect, but by including a trend variable, either a common one for all countries or, preferably, one for each region, we make an attempt to control for this trend in regulations.[32] It is also examined if there are any industry- or region-specific characteristics that explain the variation in establishment behavior. This is done by assigning additive dummies for different industries and regions.[33] The following trend and dummy variables are

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[30] The steepness of the demand curve vary across industries *and* countries, while the other explanatory variables mostly varies across firms *or* countries. This fact makes strong correlation unlikely.

[31] It is true that restrictions on acquisitions and foreign ownership have been more common for some industries, e.g. banking, insurance, television, defence and oil industries. No Swedish MNCs operate in these industries, however, implying that such restrictions can be regarded as country- or region-specific effects in this study.

[32] The common trend variable takes on the value of 1 for the 1962-65 period, 2 for 1966-70, etc., up to 6 for 1986-90. The trend variable for a specific region takes on the same values for different time periods as long as this region is considered, but 0 for all other regions irrespective of time period. Estimations were also undertaken where we used trend variables for each host country. These trend variables were, however, correlated with the other host country variables, meaning that a lot of the explanatory power of the latter variables disappeared. We therefore included trend variables for each region instead.

[33] The industry dummies are assigned on the 4-digit ISIC-level for engineering and 3-digit level for other industries. The more detailed treatment of engineering is motivated by the fact that a majority of the MNCs belongs to this industry. There are five regions in the sample: the EC, EFTA, North America, Latin America and Asia/Oceania. The European countries included in the EC and EFTA,

included in each model in order to examine if the parameter estimates for the main variables are robust:

Model A: A trend variable and additive dummies for industries.
Model B: A trend variable for *each* region and additive dummies for industries.
Model C: A trend variable for *each* region and additive dummies for industries and regions.

5. Empirical results

Statistical tests performed for the hypothesis of independence of irrelevant alternatives (IOIA) are shown in Table 3. Overall, only one out of nine tests is rejected which suggests that IOIA is not a serious problem in the estimations. The hypothesis of IOIA is always accepted when the binary choices between *G* and *N*, and *T* and *N* are considered.[34] For the choice between greenfields and takeovers,

Table 3. Statistical tests for the hypothesis of independence of irrelevant alternatives (IOIA).

Binary choice	*G* vs *T* (β_2-β_1)			*G* vs *N* (β_2)			*T* vs *N* (β_1)		
Model	A	B	C	A	B	C	A	B	C
Chi-square	40.5 **	41.1 *	31.4	3.7	25.1	1.5	0.8	0.1	1.5
Critical chi-square									
10%-level	34.4	39.1	40.3[a]	34.4	39.1	40.3[a]	34.4	39.1	40.3[a]
5%-level	37.6	42.6	43.8[a]	37.6	42.6	43.8[a]	37.6	42.6	43.8[a]
DF	25	29	33	25	29	33	25	29	33
Accept IOIA?	No	Maybe	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: ***, ** and * indicate significance at 1, 5 and 10 percent level, respectively.
[a] For 30 degrees of freedom.

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respectively, vary across time periods depending on which organization they were members of.

[34] When omitting the third alternative for these choices as a two-response logit model is estimated, only a few observations are lost.

on the other hand, the IOIA hypothesis is rejected in model A, only with some hesitation accepted in model B and accepted in model C.[35] Thus, it seems like the inclusion of more dummy and trend variables makes the assumption of IOIA less controversial. We will, accordingly, place most emphasis on model C when evaluating the results for the choice between greenfields and takeovers.

The results of the estimations are summarized in Tables 4, which is directly comparable with Table 2 showing the hypotheses. In general, the results are in line with the hypotheses for *PA*, *OPS*, *RD*, *GDP*, *ESL* and *DIST*, while the results are weak for *MG* and *LS*. The hypotheses are sometimes confirmed for *DL* and *OPEN*. It should also be mentioned that the trend variables explain a lot of the variation in the dependent variable.

Considering the choice between greenfields and takeovers, previous presence, *PA*, favors takeovers, which is in line with the hypothesis that a new venture would hurt the investing firm's previous manufacturing affiliates. The parameter estimate is always significant at the 1%-level. The hypothesis that market growth, *MG*, would facilitate new ventures is not confirmed. The estimated coefficient is positive, but never significant. The results give some evidence that high-tech firms prefer greenfields to takeovers and that firms with large plant size use takeovers. The parameter estimates of *RD* and *OPS* are significant at the 10%-level in all models. The impact of the development level of the host country, *DL*, on the probability of greenfields turns out to be negative as expected. The coefficient is significant at the 5%-level in model C, which is the most satisfactory model from a statistical point of view. It is also interesting to note that the last five variables associated with the entry decision have no significant impact on the choice between greenfields and takeovers. Generally, with the exception of the parameters for the variable *DL*, the significance levels of the estimated parameters are, rather stable across the three models, although the IOIA hypothesis could only be clearly accepted in model C.

Turning to the choice between greenfield and no entry, the parameter signs of *MG* and *OPS* are positive, as hypothesized, but never significant. Previous presence in the market, *PA*, which was expected to have an uncertain influence on

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[35] For this binary choice, there is a difference of more than 11,000 observations between the multinomial and the two-response logit estimations which are compared to each other.

Table 4. Summarized results for model III.

Method = Non-ordered multinomial logit									
Dependent variable = Y (Establishment choice)									
Explanatory variables	G vs T (β_2-β_1)			G vs N (β_2)			T vs N (β_1)		
	A	B	C	A	B	C	A	B	C
PA	- ***	- ***	- ***	+ ***	+ ***	+ **	+ ***	+ ***	+ ***
MG	+	+	+	+	+	+	-	-	-
OPS	- *	- *	- *	+	+	+	+ ***	+ ***	+ ***
SI	-	-	-	-	-	-	+ **	+	+ **
RD	+ *	+ *	+ *	+ ***	+ ***	+ ***	+	+	+
DL	-	-	- **	- ***	- **	- *	- *	-	+
LS	+	+	+	+	+	+	+	+	+
GDP	+	+	+	+ ***	+ ***	+ ***	+ ***	+ ***	+ ***
ESL	+	+	+	+ **	+ **	+	+	+ **	+
DIST	+	+	-	- ***	- ***	- ***	- ***	- ***	- ***
OPEN	-	+	+	-	-	-	+	- **	- **
No. of obs. of which Y=1 of which Y=2	12 397 430 246								

Note: The signs show the estimated impacts of the explanatory variables on the establishment choice. ***, ** and * indicate significance at 1, 5 and 10 percent, respectively. Complete parameter estimates and standard errors can be found in appendix Table 5 (β_2-β_1), Table 6 (β_2) and Table 7 (β_1).

the odds between new ventures and no entry, have a positive and significant impact on the probability of greenfields. Thus, it seems that the gain in utilizing fixed costs is larger than the damage on the previous affiliates when setting up a new production plant. The technological specialization of the investing firm, *RD*, clearly favors greenfields as hypothesized. The parameter is significant at the 1%-level in all models. The parameter of *DL* has a negative sign and the significance varies between the 10%- and 1%-level. Considering the variables affecting the entry choice, *GDP*, *ESL*, and *DIST*, all have the expected impact and the parameter estimates are mostly significant. *LS* and *OPEN* fail to show any influence on the

greenfield/no entry decision.

As hypothesized, *PA* and *OPS* exert a positive impact on the probability of acquisition compared to the alternative of refraining from investment. The estimated parameters are significant at the 1%-level. The parameters for *MG*, *RD* and *DL*, which were hypothesized to have a zero or ambiguous sign, are never significant. On the other hand, both *GDP* and *DIST* strongly influence the choice between takeovers and no entry while the results for *ESL* and *OPEN* are somewhat scattered.

6. Conclusions

This chapter has examined the choice between greenfields and takeovers in FDI, using a pooled cross-sectional data set on Swedish MNCs. A new empirical model with a corresponding statistical method is introduced where the firm has the alternative: to refraining from investment altogether. Earlier empirical studies have taken the decision to invest in the host country as given; however, the alternative to set up a new venture may be to stay out rather than make a takeover. A trinomial probit model would be best suited for the empirical analysis of the investment choice problem. Statistical tests suggest, however, that it is no problem to use a trinomial logit model if a sufficient number of dummies for industries and regions are included in the model. It would also be possible to drop the no entry alternative and use a binomial logit model instead, but the estimates would then be inefficient.

Most of the previous studies have assumed that a takeover is less risky and yields a lower rate of return than a greenfield, in turn leading to that primarily large MNCs with long experience should use greenfields as mode of entry. This hypothesis has, however, got weak support in statistical estimations. In contrast, the starting point in the present study is that MNCs operate in oligopolistic markets and that a new venture adds production capacity and lowers profits in the industry.

The main result is that previous presence in the market favors acquisitions, since a new venture would hurt the investing firm's previous manufacturing affiliates in the market. Furthermore, there is some evidence that MNCs with a large optimal

plant size are more likely to enter through takeovers. The explanation may be that a large establishment in the case of a greenfield investment is a correspondingly large threat on the market. Such firms would therefore have a stronger bargaining position than firms with small plants and should be able to lower the acquisition price of local firms. It also seems that high-tech firms prefer new ventures as entry mode, as technologically specialized firms should be more dependent on their own production technology, or face compatibility problems with the technology of the existing local firms.

Concerning generalizations of the results, Swedish MNCs have behaved the same as MNCs based in other countries with respect to increased emphasis on developed markets and increased use of takeovers rather than greenfield operations. Differences may, however, occur due to the Swedish firms' long experience or small home country market. There is a need of further studies on the determinants of the entry mode, as well as on how the entry mode affects the established affiliate's linkages to the local industry.

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Appendix

Table 5. Parameter estimates for the choice between greenfields and takeovers.

Method = Non-ordered multi-response logit			
Dependent variable = Y (Establishment choice)			
Explanatory variables	G vs T (β_2-β_1)		
	Model A	Model B	Model C
PA	-0.562 *** (0.204)	-0.534 *** (0.205)	-0.564 *** (0.207)
MG	0.088 (0.069)	0.081 (0.071)	0.091 (0.072)
OPS	-3.71 E-4 * (1.95 E-4)	-3.69 E-4 * (1.96 E-4)	-3.79 E-4 * (1.95 E-4)
SI	-4.62 E-3 (2.88 E-4)	-4.02 E-4 (2.94 E-4)	-4.97 E-4 (3.11 E-4)
RD	5.10 * (2.99)	5.05 * (2.99)	5.13 * (2.99)
DL	-0.308 (0.297)	-0.479 (0.308)	-0.713 ** (0.364)
LS	1.33 E-3 (3.28 E-3)	1.28 E-3 (3.27 E-3)	1.18 E-3 (3.28 E-3)
GDP	7.73 E-5 (5.68 E-5)	3.91 E-5 (8.59 E-5)	6.88 E-5 (9.06 E-5)
ESL	0.087 (0.089)	0.027 (0.094)	5.04 E-3 (0.100)
DIST	2.43 E-3 (7.69 E-3)	1.33 E-3 (0.010)	-5.69 E-3 (0.011)
OPEN	-0.076 (0.079)	0.079 (0.107)	0.127 (0.119)
Number of obs.	12 397		
of which Y=1	430		
of which Y=2	246		

Note: Standard errors in parentheses. ***, ** and * indicate significance at 1, 5 and 10 percent respectively. Intercepts, dummies and trend variables are shown in Table 8.

Table 6. Parameter estimates for the choice between greenfields and no entry.

Method = Non-ordered multi-response logit			
Dependent variable = Y (Establishment choice)			
Explanatory variables	G vs N (β_2)		
	Model A	Model B	Model C
PA	0.511 *** (0.174)	0.473 *** (0.175)	0.409 ** (0.176)
MG	0.061 (0.055)	0.077 (0.056)	0.086 (0.057)
OPS	1.29 E-4 (1.71 E-4)	1.36 E-4 (1.71 E-4)	1.43 E-4 (1.70 E-4)
SI	-7.32 E-5 (2.29 E-4)	-1.61 E-4 (2.33 E-4)	-9.23 E-5 (2.45 E-4)
RD	7.18 *** (2.34)	7.15 *** (2.34)	7.29 *** (2.34)
DL	-0.637 *** (0.237)	-0.600 ** (0.243)	-0.544 * (0.294)
LS	4.21 E-3 (2.75 E-3)	4.24 E-3 (2.75 E-3)	4.21 E-3 (2.76 E-3)
GDP	1.81 E-4 *** (4.82 E-5)	2.28 E-4 *** (6.94 E-4)	2.58 E-4 *** (7.39 E-5)
ESL	0.142 ** (0.071)	0.152 ** (0.076)	0.089 (0.082)
DIST	-0.023 *** (6.07 E-3)	-0.031 *** (7.65 E-3)	-0.039 *** (8.43 E-3)
OPEN	-0.023 (0.062)	-0.089 (0.079)	-0.053 (0.088)
Number of obs. of which $Y=1$ of which $Y=2$	12 397 430 246		

Note: Standard errors in parentheses. ***, ** and * indicate significance at 1, 5 and 10 percent respectively. Intercepts, dummies and trend variables are shown in Table 9.

Table 7. Parameter estimates for the choice between takeovers and no entry.

Method = Non-ordered multi-response logit			
Dependent variable = Y (Establishment choice)			
Explanatory variables	T vs N (β_1)		
	Model A	Model B	Model C
PA	1.073 *** (0.118)	1.007 *** (0.120)	0.972 *** (0.120)
MG	-0.026 (0.044)	-4.05 E-3 (0.045)	-5.04 E-3 (0.046)
OPS	5.01 E-4 *** (1.09 E-4)	5.11 E-4 *** (1.10 E-4)	5.21 E-4 *** (1.13 E-4)
SI	3.84 E-4 ** (1.92 E-4)	2.46 E-4 (1.96 E-4)	4.14 E-4 ** (2.07)
RD	2.08 (2.01)	2.11 (2.01)	2.15 (2.02)
DL	-0.329 * (0.190)	-0.121 (0.199)	0.169 (0.226)
LS	2.88 E-3 (1.91 E-3)	2.96 E-3 (1.91 E-3)	3.03 E-3 (1.92 E-3)
GDP	1.03 E-4 *** (3.62 E-5)	1.89 E-4 *** (5.43 E-5)	1.89 E-4 *** (5.66 E-5)
ESL	0.055 (0.056)	0.125 ** (0.059)	0.084 (0.061)
DIST	-0.025 *** (4.97 E-3)	-0.032 *** (6.76 E-3)	-0.033 *** (6.96 E-3)
OPEN	0.052 (0.051)	-0.168 ** (0.075)	-0.180 ** (0.081)
Number of obs. of which Y=1 of which Y=2	12 397 430 246		

Note: Standard errors in parentheses. ***, ** and * indicate significance at 1, 5 and 10 percent respectively. Intercepts, dummies and trend variables are shown in Table 10.

Table 8. Supplement to Table 5. Intercepts, dummies and trend variables.

G vs T (β_2-β_1)	Model A		Model B		Model C	
Explanatory variables	Parameter	Std.error	Parameter	Std.error	Parameter	Std.error
Intercept	5.91 **	2.48	5.04 *	2.58	5.29 **	2.66
ID Food	-0.535	0.337	-0.528	0.338	-0.535	0.338
ID Textiles	-0.999 ***	0.328	-0.979 ***	0.328	-0.985 ***	0.328
ID Paper & pulp	0.220	0.277	0.223	0.278	0.229	0.278
ID Paper products	-0.434	0.278	-0.420	0.279	-0.418	0.279
ID Chemicals	-0.215	0.251	-0.214	0.251	-0.208	0.252
ID Iron & steel	-0.499 *	0.262	-0.491 *	0.263	-0.494 *	0.263
ID Metal products	-0.246	0.256	-0.239	0.257	-0.245	0.257
ID Machinery	-0.345	0.249	-0.335	0.250	-0.351	0.250
ID Electronics	-0.301	0.259	-0.286	0.260	-0.299	0.260
ID Transports	-0.560	0.293	-0.543 *	0.294	-0.554 *	0.294
ID Instruments	-0.384	0.471	-0.390	0.471	-0.380	0.471
ID Wood products	-0.319	0.338	-0.311	0.338	-0.312	0.338
TV	-0.466 ***	0.064	---	---	---	---
TV EC	---	---	-0.495 ***	0.066	-0.591 ***	0.090
TV EFTA	---	---	-0.465 ***	0.087	-0.299 ***	0.113
TV North America	---	---	-0.343 ***	0.124	-0.490 ***	0.187
TV Latin America	---	---	-0.355 ***	0.130	-0.404 **	0.194
TV Asia/Oceania	---	---	-0.228 **	0.110	-0.205	0.207
RD EFTA	---	---	---	---	0.505 *	0.274
RD North America	---	---	---	---	-0.258	0.444
RD Latin America	---	---	---	---	-3.81 E-4	0.468
RD Asia/Oceania	---	---	---	---	0.053	0.501

Note: Standard errors in parentheses. ***, ** and * indicate significance at 1, 5 and 10 percent respectively. ID = Industry dummy, TV = Trend variable and RD = Region dummy. The cement industry and the EC are the reference groups for the industry and region dummies, respectively.

Table 9. Supplement to Table 6. Intercepts, dummies and trend variables.

G vs N (β_2)	Model A		Model B		Model C	
Explanatory variables	Parameter	Std.error	Parameter	Std.error	Parameter	Std.error
Intercept	-3.16	2.11	-2.43	2.17	-2.78	2.22
ID Food	0.208	0.273	0.202	0.273	0.218	0.273
ID Textiles	0.028	0.239	2.60 E-3	0.239	0.022	0.240
ID Paper & pulp	0.302	0.246	0.303	0.246	0.307	0.246
ID Paper products	-0.293	0.231	-0.297	0.231	-0.292	0.231
ID Chemicals	0.138	0.216	0.146	0.216	0.149	0.216
ID Iron & steel	-0.248	0.217	-0.254	0.217	-0.250	0.217
ID Metal products	0.174	0.222	0.170	0.222	0.177	0.222
ID Machinery	-0.024	0.212	-0.034	0.212	-0.021	0.213
ID Electronics	-0.209	0.222	-0.219	0.223	-0.211	0.223
ID Transports	-0.047	0.238	-0.056	0.238	-0.041	0.238
ID Instruments	0.407	0.354	0.416	0.354	0.418	0.354
ID Wood products	0.055	0.283	0.051	0.283	0.051	0.283
TV	-0.196***	0.050	---	---	---	---
TV EC	---	---	-0.176***	0.053	-0.290***	0.072
TV EFTA	---	---	-0.288***	0.071	-0.157*	0.090
TV North America	---	---	-0.313***	0.100	-0.166	0.146
TV Latin America	---	---	-0.154	0.101	-0.442***	0.144
TV Asia/Oceania	---	---	-0.200**	0.080	-0.140	0.130
RD EFTA	---	---	---	---	0.501**	0.199
RD North America	---	---	---	---	0.644**	0.326
RD Latin America	---	---	---	---	-0.602*	0.327
RD Asia/Oceania	---	---	---	---	0.193	0.309

Note: Standard errors in parentheses. ***, ** and * indicate significance at 1, 5 and 10 percent respectively. ID = Industry dummy, TV = Trend variable and RD = Region dummy. The cement industry and the EC are the reference groups for the industry and region dummies, respectively.

Table 10. Supplement to Table 7. Intercepts, dummies and trend variables.

T vs N (β_1)	Model A		Model B		Model C	
Explanatory variables	Parameter	Std.error	Parameter	Std.error	Parameter	Std.error
Intercept	-9.07***	1.40	-7.47***	1.50	-8.06	1.57
ID Food	0.743***	0.207	0.729***	0.208	0.753***	0.208
ID Textiles	1.027***	0.231	0.982***	0.232	1.009***	0.231
ID Paper & pulp	0.082	0.139	0.080	0.140	0.078	0.140
ID Paper products	0.141	0.167	0.123	0.168	0.127	0.168
ID Chemicals	0.353**	0.139	0.359***	0.140	0.356**	0.140
ID Iron & steel	0.250	0.158	0.237	0.159	0.244	0.159
ID Metal products	0.420***	0.139	0.409***	0.140	0.423***	0.140
ID Machinery	0.321**	0.140	0.301**	0.141	0.330**	0.142
ID Electronics	0.092	0.145	0.067	0.146	0.088	0.146
ID Transports	0.514***	0.181	0.487***	0.182	0.512***	0.182
ID Instruments	0.790**	0.319	0.806**	0.319	0.798**	0.319
ID Wood products	0.374*	0.195	0.362*	0.196	0.364*	0.196
TV	0.270***	0.041	---	---	---	---
TV EC	---	---	0.320***	0.042	0.301***	0.057
TV EFTA	---	---	0.177***	0.053	0.142**	0.072
TV North America	---	---	0.030	0.078	0.323***	0.125
TV Latin America	---	---	0.201**	0.085	-0.039	0.132
TV Asia/Oceania	---	---	0.028	0.076	0.065	0.163
RD EFTA	---	---	---	---	-3.84 E-3	0.197
RD North America	---	---	---	---	0.901***	0.319
RD Latin America	---	---	---	---	-0.601*	0.343
RD Asia/Oceania	---	---	---	---	0.139	0.400

Note: Standard errors in parentheses. ***, ** and * indicate significance at 1, 5 and 10 percent respectively. ID = Industry dummy, TV = Trend variable and RD = Region dummy. The cement industry and the EC are the reference groups for the industry and region dummies, respectively.

Chapter III

Host Country Characteristics and Agglomeration in Foreign Direct Investment*

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 specialized in similar production, i.e. agglomeration will arise.

The question addressed in this paper concerns how different host country characteristics affect the locational decision of overseas production. The main objective is to examine whether agglomeration patterns can be detected in FDI, and

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* This chapter is jointly written with Pontus Braunerhjelm, IUI.

to which extent such agglomeration differs between industries. 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 paper is organized as follows. Section 2 reviews the theoretical framework of FDI as well as earlier empirical results. The database and sample selection are described in section 3. In section 4, the econometric specification is presented and the hypotheses are set up in section 5. The results are provided in section 6, while the final section concludes.

2. Foreign direct investment and agglomeration patterns

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:[1]

Demand and supply linkages. The "new" location theory emphasizes "pecuniary" externalities 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.[2] 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 (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

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[1] 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).

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

constitute a locational advantage.

An overall framework with regard to FDI is Dunning's (1977) OLI-approach, which - rather than providing a full theory - discusses the necessary conditions for FDI 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 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, however. 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 analysis.

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.[3]

Thus, from the studies cited above a number of variables can be distinguished that influence the locational choice of firms, although less light has been shed on the tendencies towards agglomeration in FDI. 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 used 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 turn into 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; Head *et al.*, 1995). Japanese firms have predominantly entered into industries in which the host countries have already revealed comparative advantages.

3. The database and sample selection

The data set on Swedish MNCs has been collected by the Industrial Institute for

[3] 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).

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 in Europe and North America, and the major countries in Latin America.[4] This is, however, not a cause of great concern since more than 95 percent of foreign production of Swedish MNCs is undertaken in these countries. Data on country and industry levels, if not specified elsewhere, are taken from UN (1980, 1989, 1992) 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: First, whether to establish a manufacturing affiliate in a country at all, and, second, if an affiliate is established, to decide the appropriate level of operation. For each specific country, the alternative to choosing a high level of production may, in fact, be to locate no affiliates 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. Particularly, it is conceivable that lack of knowledge or experience of a country will

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[4] 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.

Table 1. Comparison between establishment of foreign manufacturing affiliates and firms' previous exports to the market, by industry, 1975-1990.

Industry	No. of establishments of foreign affiliates	No. of foreign establishments that where proceeded by parent 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: Establishments of foreign manufacturing affiliates in the 1987-90 (1979-86, 1975-78) period are here compared to the investing firm's parent exports to the host country in the 1986 (1978, 1974) survey.

[a] 'Other' industries include the food, textile, paper products, wood products and cement industries.

increase the risk associated with FDI. One channel through which firms acquire knowledge about foreign markets are exports. Table 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. Countries to which firms export should therefore be strong candidates for FDI.[5] Exceptions to this pattern relate to industries where serious trade barriers have made export impossible, as in the gas (chemicals), cement, food and textile (others) industries.

When selecting the sample 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.

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

4. Econometric specification

The dependent variable is net sales of firm *i's* affiliates located in country *j* at time *t*, NS_{ijt}.[6] *NS* is divided with total sales of the firm, TS_{it}, in order to control for historical factors as well as economies of scale on the firm level. The variable *NS/TS* is characterized by a large share of zeroes (more than 60%), since the sample includes countries where firms have no affiliate production as well as countries where affiliates have been established. The model explaining the variation in overseas production is specified as:

$$\frac{NS_{ijt}}{TS_{it}}^{*} = \beta_0 + Z'\beta_1 + \epsilon_{ijt} , \tag{1a}$$

$$\frac{NS_{ijt}}{TS_{it}} = \begin{cases} \frac{NS_{ijt}}{TS_{it}}^{*} & if \quad \frac{NS_{ijt}}{TS_{it}}^{*} > 0 \\ 0 & if \quad \frac{NS_{ijt}}{TS_{it}}^{*} \leq 0 \end{cases} . \tag{1b}$$

The residuals are assumed to have the properties $\epsilon \sim N(0, \sigma_\epsilon^2)$, $E(\epsilon_{hjt}\epsilon_{ijt})=0$ for $h \neq i$, and $E(\epsilon_{ijt}\epsilon_{ikt})=0$ for $j \neq k$.[7] 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*. Although this is not taken into account in the estimation procedure, the parameter estimates will still be consistent (Hsiao, 1986).[8]

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

[7] In this particular model, the dependent variable is restricted by an upper limit, $NS/TS \leq 1$. As long as the predicted value of *NS/TS* for any observation never reaches the limit, the normal distribution is a good approximation for the residuals. In the estimations, no predicted value of *NS/TS* is larger than 0.4.

[8] 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 capture fixed effects.

Under these circumstances, one appropriate statistical method for estimating equation (1) is the Tobit method via maximum likelihood procedures (Tobin, 1958). 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.

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 of non-zero observations is not random.

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. A possible decomposition of the parameters into separate probability and marginal effects is shown in McDonald and Moffitt (1980), but the problem is that the two separate effects will always have the same sign. The effect of an explanatory variable on the probability to locate production in a country may, however, differ from the marginal effect on the level of production conditional on that affiliates already are established. It is possible to estimate these impacts separately by using a selection bias corrected regression method, SBCR (Heckman, 1976). 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:

$$F^{-1}(Pr(Y)_{ijt}) = J_{ijt} = \alpha_0 + Z'\alpha_1 \ , \qquad (2)$$

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:

$$\lambda_{ijt} = \frac{f(-J_{ijt})}{(1 - F(-J_{ijt}))} , \qquad (3)$$

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:

$$\frac{NS_{ijt}}{TS_{it}} = \gamma_0 + Z'\gamma_1 + \sigma\tilde{\lambda}_{ijt} + \nu_{ijt} . \qquad (4)$$

The residuals are 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 $s \neq t$. Since Heckman's lambda is included, this OLS equation will yield consistent parameter estimates. White's (1980) corrected standard errors are used to obtain consistent estimates of the standard errors of the estimated parameters. The γ's are here the marginal effects of the explanatory variables on overseas production.

5. Hypotheses for empirical testing

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 2, 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.[9] For two reasons, this variable

[9] 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

is 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 captures 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.[10] 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).[11]

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 and have received support in most empirical analyses (GDP_{jt}), It is expected to have a positive influence on host country production. Furthermore, 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

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

[10] 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.

[11] 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.

openness of the host country has also been included ($OPEN_{jt}$).[12] *OPEN* takes on values from 1 to 10, where 10 means high openness. Here we assume that protection encourages MNCs to locate production in the host country. Another index measures the distance between Sweden and the host country ($DIST_{jt}$). A large distance, i.e. a high value of *DIST*, is assumed to decrease the probability, and the extent, of production in the host country.[13]

As discussed in section 3, establishment of production should be influenced by the historical trade pattern of the firm. 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 total sales of the firm in period *t-1*. By using the lagged value of exports, we make an attempt to reduce simultaneity problems.[14] The larger the exports, the higher the level of market knowledge, which is assumed to positively influence the location of production to that market (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.[15] 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

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[12] This index includes (1), limits to foreign ownership and, (2), government requirements that a certain percentage of local components must be used in production. The Wheeler-Mody index was constructed for the U.S., but it has here been modified to conform better with the Swedish situation by including the data on trade barriers in Leamer (1990).

[13] This variable takes both (1), geographical and, (2), cultural and linguistic distance into account (Nordström, 1991). 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 distance ranking: Nordic countries, other North European countries, North America, South European countries, and, finally, Latin America.

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

[15] 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).

should be correlated with the human capital within the company. Both *RD* and *LS* are therefore likely to exert a positive impact on the propensity to produce abroad.

Another variable, high initial capital costs on plant level (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.[16]

Dummies. By including additive dummy variables, we examine whether any shifts in the level of the dependent variable occur over time or across regions.[17] 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).[18]

In the basic estimations, 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 the SBCR model, however, the parameter of *AGGL* is allowed to vary across high and low technology industries.[19] This is accomplished by assigning an interaction dummy to *AGGL* for one of the industry groups.

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

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

[18] The industry dummies are assigned on the 4-digit ISIC-level for engineering and 3-digit level for other industries. This is motivated by the fact that a majority of the firms belongs to the engineering 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. A usual Tobit model with firm-specific effects will not yield consistent parameter estimates, unless there are several observations per firm in the data set. In our sample, however, there are 23 observations per firm on average.

[19] 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.

6. Empirical results

The results of the Tobit estimations are shown in Table 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 that agglomeration influences 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 estimate 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.

Considering 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 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 estimated 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

Table 2. Estimation results of the Tobit model (equation 1).

Method = Tobit	Dependent variable = *NS/TS*	
Independent variables	Model (I)	Model (II)
AGGL	0.018 ** (8.55 E-3)	0.017 * (8.58 E-3)
$(XF/TS)_{t-1}$	0.494 *** (0.121)	0.638 *** (0.126)
GDP	3.25 E-6 *** (7.30 E-7)	3.21 E-6 *** (7.34 E-7)
RSET	7.75 E-3 *** (2.88 E-3)	7.98 E-3 *** (2.90 E-3)
OPEN	-5.34 E-3 (4.17 E-3)	-5.70 E-3 (4.20 E-3)
DIST	-1.01 E-3 ** (4.07 E-4)	-1.02 E-3 ** (4.09 E-4)
RD	0.486 * (0.264)	0.714 *** (0.264)
LS	3.17 E-4 *** (1.22 E-4)	3.81 E-5 (1.41 E-4)
HIC	1.88 E-4 *** (4.61 E-5)	6.80 E-5 (6.82 E-5)
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 5, while intercept and dummies for time regions and firms in model (II) are shown in appendix Table 6.

level of affiliate production in the OLS equation, while no such influence can be observed on the dichotomous location decision in the probit equation.[20] The parameter of *DIST* has the expected negative sign, but the significance is stronger

[20] *OPEN* should primarily influence the decision whether to locate affiliates in a country or not, rather than having an impact on the level of production given that affiliates have been established. The opposite results with respect to significance levels may depend on that *OPEN* is not an appropriate measure of the host country's tariff policy. No alternative measure is, however, available.

Table 3. Estimation results of the SBCR model (equations 2-4).

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)
$\tilde{\lambda}$	---	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 5, while intercepts and dummies for time, region and firms in model (II) are shown in appendix Table 6.

[a] at critical probability of 0.5.

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 with respect to significance levels 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 the SBCR model, Table 4 shows that *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 3. In model (II), the parameter is significant on the

Table 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 7. Intercepts and dummies for time, regions and industries in model (I) are shown in appendix Table 8. Intercepts and dummies for time, regions and firms in model (II) are shown in appendix Table 9.

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 7) are analogous to those in models (I) and (II) (Table 3).

7. 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. It also indicates that an initially modest advantage may grow into a substantial production advantage over time through FDI. 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 strong 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, implying 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 shows that these two decisions are partly determined by different factors.

If economies of agglomeration turn out to be increasingly important in firms' investment decisions then, 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.

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Appendix

Table 5. Supplement to Tables 2 and 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. Supplement to Tables 2 and 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 7. Supplement to Table 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)
$\tilde{\lambda}$	---	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 8. Supplement to Table 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 for the region dummies and 1990 is the reference period.

Table 9. Supplement to Table 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 IV

Effects of Overseas Production on Home Country Exports

1. Introduction

It is generally accepted that activities abroad enable a firm to operate more efficiently as a whole, and to increase market shares, but the home country effects have been widely debated. For instance, is foreign direct investment (FDI) matched by inward investment? Or are such gaps filled by indigenous firms? To what extent does FDI affect specialization, trade and growth at home? These matters seem to be of particular relevance for small open economies.

One way to analyze the effects on the home economy is to relate activities abroad with those at home within the same multinational corporation (MNC). In this paper, I focus on the effects of foreign production on parent exports, i.e. commodity flows on the demand side of the firm that are related to each other. In traditional theoretical models (see Caves, 1982, for a survey), firms supply a foreign market either through affiliate production within the host country, by licensing production to another firm or by exporting from the home country. The firm's market share in the host country is assumed to be given in these models. Accordingly, production abroad simply replaces exports from the home country. As soon as this assumption of fixed market shares is relaxed, however, the effects become unsettled.

Of empirical work, most analyses of commodity flows on the demand side of the firm have denied the presence of substitution effects.[1] Using U.S. data,

[1] Another strand of empirical literature has found evidence for substitution effects in the sense that investments abroad crowd out those at home, e.g. Severn (1972), Stevens and Lipsey (1992), Belderbos (1992) and Svensson (1993). These findings have mainly been attributed to internal restrictions on the supply side faced by firms in terms of limited access to financing, administrative capacity, technology,

Bergsten *et al.* (1978) maintained that there is a weak complementary effect between investment abroad and exports up to a certain level, since most initial investment goes into marketing and assembly. Beyond that level, however, further overseas capacity starts to displace exports. Lipsey and Weiss (1981, 1984) concluded that production by affiliates in a country and U.S. exports are complementary. Meanwhile, exports from other industrial countries were negatively affected by the presence of U.S. manufacturing affiliates. Using Swedish and U.S. industry data, Blomström *et al.* (1988) found that the positive impact of foreign production on home country exports dominated, although the effect was insignificant in some industries.

The most comprehensive studies have been undertaken by Swedenborg (1979, 1982). Analyzing a set of the firm-specific data also used in this paper, she found that an increase in foreign production by $100 caused a positive net effect on parent exports by $6 and $10 in her 1979 and 1982 studies, respectively. This was because the positive effect on complementary exports to manufacturing affiliates was larger than the negative effect on exports to other recipients in the host country. The significance of these net effects was never tested, however.

A common problem with all these studies is the neglect of exports to countries in which manufacturing affiliates have not been established. To avoid sample selection bias and to evaluate the effects on parent exports consistently, such countries must be included in the statistical analysis. A second and more interesting problem concerns the relationship between exports from foreign affiliates and parent exports to "third countries". Previous work has only considered FDI oriented to the local market, although substitution effects may well arise outside the host country. In this study, these issues are addressed for the first time, using a pooled cross-sectional data set on individual Swedish MNCs 1974-90. Special care is taken to operations in the EC, which is motivated by the geographical focus of Swedish FDIs as well as the process of regional trade liberalization.[2]

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etc. Such restrictions should, however, mainly be effective in the short term perspective as FDI in the long run may facilitate an expansion also of home operations.

[2] Henceforth, the model and results are compared with Swedenborg (1979, 1982), since these are the most thorough studies and the only ones undertaken on the firm and country levels.

The chapter is organized as follows. Section 2 discusses the interaction between foreign production and exports. The models, the data base and sample selection are presented in section 3. Section 4 shows the econometric specifications, and hypotheses for exogenous variables are set up in section 5. The results are presented in section 6 and the last section concludes.

2. Interaction between foreign production and parent exports

Local production in a certain market may be motivated by lower transportation costs, avoidance of trade barriers and reduced costs, e.g. for obtaining information. Moreover, local production also makes it easier to bring products in line with local demand requirements, and the local market should become more accessible as the firm enhances its credibility as a reliable source of supply. For these reasons, the firm's sales and market shares in the particular market should increase when affiliate production is set up or expanded. Although some earlier exports of finished goods can be expected to be replaced by local production, total exports to the market may well increase as foreign production tends to require intermediate goods provided by the parent company. This complementary effect will counteract the expected substitution effect on finished goods.[3] Since it is not possible to determine on theoretical grounds whether the net effect on exports is positive or negative, this issue has to be settled empirically.[4]

When examining the impact of overseas production on parent exports, it is necessary to consider the simultaneous relationship between these flows. Many empirical studies suggest that FDIs are generally directed to countries with the smallest transactional and information-cost disadvantages due to e.g. historical connections and prevailing trade patterns (cf. Caves, 1982). Thus, Japanese FDIs

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[3] Parent exports will increase (decrease) if the increase in total sales is larger (less) than the expansion in affiliate production.

[4] The impact of foreign production on home country exports depends on how the foreign affiliate is organized with the parent (Caves, 1971). Horizontally integrated affiliates tend to replicate the activities of the parent, i.e. such production should replace parent exports to a relatively large extent. Vertically integrated affiliates are often specialized in order to utilize scale economies, which give rise to intra-firm trade of intermediate goods. It is, however, not possible to gather these organizational forms directly from statistics, and they seldom occur in pure forms.

are directed to Southeast Asia (Tsurumi, 1976), Swedish firms invest in adjacent European countries and North America (Swedenborg, 1979, 1982), French investments are located in French ex-colonies and neighboring countries in Europe (Michalet and Delapierre, 1976), and so on.

The establishment chain theory (Aharoni, 1966; Cauvisqil, 1980) starts from a similar argument and states that localization of FDI is determined by risk reduction and uncertainty. When a firm penetrates a foreign market it does so, in the first stage, by exports. At a later stage, the firm may set up a sales company and only in the last stage is a manufacturing affiliate established. In order to reduce its risk a firm bases its decision to set up production in a certain host country on information partly obtained through previous exports to the market. Thus, the FDI decision would be indirectly determined by the trade pattern of the firm, meaning that countries to which a firm already exports are strong candidates for FDI. For example, about 94 percent of all foreign establishments undertaken by Swedish MNCs between 1975 and 1990 were located in countries to which the firm was already exporting (Braunerhjelm and Svensson, 1993).[5] However, FDIs are not undertaken in all markets to which a firm exports. Accordingly, an empirical analysis examining how foreign production affects parent exports needs to incorporate all markets in which the firm has sales, either in the form of exports from the parent or local production.

To evaluate the effects on home country exports correctly, affiliate exports must also be considered. Firms often locate manufacturing affiliates in a country in order to serve a whole region. This is motivated by e.g. economies to scale at the plant level and insufficient demand for the firm's products in each individual country. When affiliates produce for exports, there should be a replacement of parent exports to the region outside the host country. The intermediate goods are, of course, exported entirely to the host country where production takes place. However, since the affiliate will then not be directly present in all markets to which it sells, it will probably not achieve at full length the advantages of information, credibility and transportation costs as described above. Thus, for a *given amount* of

[5] Exceptions are industries where barriers to trade prevent exports, as in gas, concrete, food and textile industries.

expansion in affiliate production, sales and market shares should increase more when producing for the local market than when producing for exports. This means that the net effect on parent exports is expected to be more negative, or less positive, when an affiliate exports to third countries compared to when it produces and sells in the local market only.

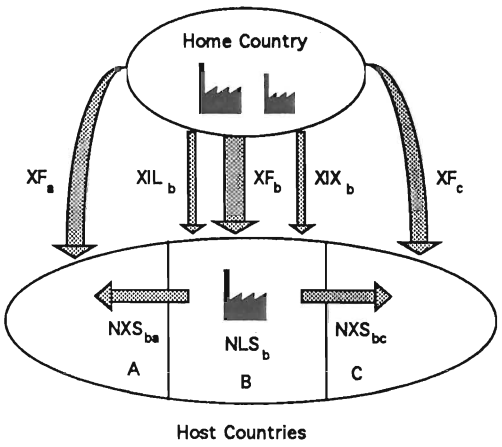
Irrespective of how increased foreign production affects parent exports, it is possible that the overall effect may be trade-creating. This is especially the case if a large share of the affiliates' production is exported. It is well known that foreign affiliates tend to integrate with each other and create international networks, i.e. some of the affiliates' exports consist of intermediate goods used as inputs in other affiliates. Another interesting aspect, which is not analyzed in this paper due to lack of data, is the impact of foreign production on subcontractors. When MNCs establish more units of production abroad, there is a possibility that subcontractors in the home country are able to raise their exports. On the other hand, there is empirical evidence in the Swedish case that domestic subcontractors are replaced by foreign ones (Braunerhjelm, 1991).

3. The models, data base and sample selection

Figure 1 shows how different flows of foreign production and parent exports, represented by factories and arrows, are related to each other (exact definitions can be found in appendix A). An MNC, originating from "the home country", has sales in the host countries *A*, *B* and *C* and a manufacturing affiliate in *B*. How an increase in affiliate production in *B* affects parent exports will be examined in the following models:

— **Model (I)**. What is produced in country *B* for local sales, i.e. net local sales, NLS_b, can be expected to replace a part of the exports of finished goods that previously went to the host country, i.e. XF_b should decline. This is tested in model (If). There will also be a complementary effect as production attracts exports of intermediate goods from the parent, i.e. XIL_b should increase, which is examined

Figure 1. Influences of foreign production on parent exports.



in model (Ii).[6] The sum of both these effects is the net effect of model (I).

– **Model (II).** The rest of affiliate production in *B* is exported to *A* and *C* in the same region, i.e. net export sales, NXS_{ba} and NXS_{bc}. In model (IIf), it is tested whether affiliate exports from *B* act as substitutes for parent exports of finished goods to third countries, XF_a+XF_c, henceforth denoted *XTH*. No such relationship has been considered in previous empirical studies. Exports of intermediate goods are also attracted, not to the third countries, but to the host country *B* where production takes place, i.e. XIX_b should increase. This is analyzed in model (IIi). The sum of these effects is the net effect of model (II), which is expected to be more negative or less positive than the net effect in model (I).

The data base on Swedish MNCs has been collected by the Industrial Institute for

[6] Swedenborg (1979, 1982) distinguished between external and internal exports from the parent company. The latter flow included all exports to manufacturing affiliates in the host country, which was regarded as complementary no matter if it consisted of finished or intermediate goods. In the present study, however, parent exports are divided into intermediate and finished goods. The former flow can only be directed to manufacturing affiliates and must be complementary. The latter can also be exported directly to the customers in the host country, or via sales affiliates. This division is motivated by the fact that the exports of finished goods to affiliates could have existed even if these affiliates were not manufacturing. It can also be shown in the questionnaire that most foreign manufacturing affiliates which import finished goods from the parent originally started out as sales affiliates.

Economic and Social Research (IUI) in Stockholm and covers six years (1965, 1970, 1974, 1978, 1986 and 1990). All majority-owned producing affiliates located abroad are included, which enables analysis of foreign production at the firm level in each country. Trade statistics, especially regarding parent exports, exports from the foreign affiliates and intra-firm trade are very detailed. For the surveys included in the empirical analysis there is comprehensive data on exports to almost all developed countries but only to a few developing countries.[7] For 1974 and 1978 there are some deficiencies in the reply frequency regarding export figures. As a consequence, many small firms with only one or two foreign affiliates have been excluded for these years.

When selecting the sample, one has to take into account that parent exports are also directed to countries where the firm has decided not to locate any manufacturing affiliates. Such observations should be compared with countries where affiliate production takes place. In fact, the firm has to make two decisions simultaneously when locating production abroad: 1) Whether to locate a manufacturing affiliate in a country or not; 2) If an affiliate is established, to decide the appropriate level of operation. The alternative to choosing a high level of production may be to refrain from establishment or exit the market rather than operate with a small production plant. Since the two decisions are interrelated, they will both affect parent exports. If one only considers countries where affiliate production is established, then the first decision is ignored. By instead including all countries in which the firm has sales in our sample we avoid systematic sample selection bias.

Some further remarks on the data sets used in the estimations are warranted:

– Model (I) includes countries from all over the world, but is biased towards industrialized countries. This is not a major cause of concern, however, since 87% of exports and 98% of foreign production of Swedish MNCs are covered. Every time the firm has sales on a foreign market, it is included once - whether the firm has production there or not.

– For two reasons, only the EC is analyzed when the hypotheses in model (II)

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[7] Exports from Sweden are measured consistently only since 1974. The surveys of 1965 and 1970 have therefore been excluded from the analysis.

are tested on a regional basis.[8] First, exports from affiliates to neighboring countries mainly take place in the industrialized world, especially within the EC, as shown in Table 1. In this region, net export sales as a share of net sales in affiliates has been large throughout. In North America and developing countries, the propensity of affiliates to export has always been fairly limited.[9] Second, we need a geographically and economically integrated region which is also relatively homogeneous. Unfortunately, we do not have data on exports from foreign subsidiaries to specific countries other than the parent country. It is here assumed that the rest of exports

Table 1. Exports from affiliates as a share of total affiliate production and parent exports for Swedish MNCs by region in 1978 and 1990. Percent.

Region	Affiliate exports to third countries (*NXS*) as a percentage of			
	affiliate net sales (*NS*)		parent exports	
	1978	1990	1978	1990
EC	30.2	32.7	38.6	56.6
EFTA	12.7	25.8	5.6	22.4
North America	11.4	11.5	14.8	27.8
Developing countries	8.4	6.9	21.3	48.4
All regions	23.8	26.2	28.0	46.9

Note: Different affiliates are included in different years. This means that the increased export-intensity in e.g. EFTA may depend on that new affiliates with a high propensity to export have joined the sample rather than that given affiliates have changed their behavior.

[8] Luxembourg has been excluded all years and Ireland was only included in 1990 due to lack of data. Greece, Portugal and Spain were not included in 1974 and 1978, as they were not yet members in the EC.

[9] North America only consists of two large national markets, which may explain the low levels in this case. According to the product-cycle-theory (Vernon, 1966), one could expect that affiliate exports should be especially high from developing countries, where factor prices are low. In contrast to MNCs from the U.S. and Japan, however, Swedish MNCs have not used such off-shore production to any great extent. Not surprisingly, the share is very small in Latin America. Here, each country is a separate market due to high tariff barriers.

from affiliates are directed to the other EC-countries.[10] In model (II), the selection criteria is the same as in model (I), but now a firm must also have some sales in the rest of the region, outside the host country. If this is fulfilled for a firm in a specific country, it is included once.

Looking at some empirical observations, Table 1 shows that the shares of affiliate exports to affiliate production and parent exports, respectively, have always been large in the EC. The importance of this observation is emphasized by the fact that the EC accounts for about half of foreign production and parent exports of Swedish MNCs. Parent exports to developing countries have always been at an extremely low level, explaining the large "jump" in the latter share between 1978 and 1990.

Table 2 reports the development of exports of Swedish MNCs, decomposed into parent and affiliate exports, compared to world and OECD exports. The MNCs have largely defended their market shares in the period 1970-90, yet this trend can be entirely explained by the strong performance of affiliate exports. While the

Table 2. Swedish MNCs' exports as a share of total world and OECD exports, 1970-90. Percent.

	1970	1974	1978	1986	1990
Swedish MNCs' exports as a share of					
World exports	1.6	1.4	1.4	1.4	1.4
OECD exports	2.2	2.2	1.9	2.0	1.9
Swedish parent exports as a share of					
World exports	1.4	1.2	1.1	1.1	0.9
OECD exports	1.9	1.9	1.5	1.5	1.2
Foreign affiliates' exports as a share of					
World exports	0.2	0.2	0.3	0.3	0.5
OECD exports	0.3	0.3	0.4	0.5	0.7

Source: Andersson *et al.* (1996).

[10] One may argue that both the EC and EFTA should be included in this model, i.e. an affiliate located in an EC-country may export to EFTA or vice versa. The integration of these two regions is, however, not as comprehensive as that of the EC-countries. Firms which locate affiliates in the EC generally aim for an increased market share in the Single Market, rather than exports to countries outside the EC.

parents' share of world exports fell from 1.2 to 0.9 percent, that of the affiliates more than doubled.

4. Econometric specification

The main variables are foreign production and parent exports. In all of the models, these variables are divided by total sales of the whole MNC, *TS*, since one would expect both production and exports to be increasing with firm size, due to historical factors as well as economies to scale on the firm level.[11] Accordingly, NLS_{ijt}/TS_{it} and XF_{ijt}/TS_{it} measure firm i's intensities to produce for local sales in, and to export finished goods to country j, respectively, at time t.

The following equations show the specification for *NLS*/*TS* and *XF*/*TS* in model (If), but they are valid also for model (IIf) by simply substituting *NXS* and *XTH* for *NLS* and *XF*, respectively:

$$\frac{NLS_{ijt}^{*}}{TS_{it}} = \alpha_0 + \alpha_1 \frac{XF_{ijt}}{TS_{it}} + Z_1'\alpha + \mu_{ijt} , \tag{1a}$$

$$\frac{NLS_{ijt}}{TS_{it}} = \begin{cases} \dfrac{NLS_{ijt}^{*}}{TS_{it}} & if \ \dfrac{NLS_{ijt}^{*}}{TS_{it}} > 0 \\ 0 & if \ \dfrac{NLS_{ijt}^{*}}{TS_{it}} \le 0 \end{cases} , \tag{1b}$$

$$\frac{XF_{ijt}}{TS_{it}} = \beta_0 + \beta_1 \frac{NLS_{ijt}^{*}}{TS_{it}} + Z_2'\beta + \epsilon_{ijt} . \tag{2}$$

The residuals are assumed to have the desired properties: $\epsilon \sim N(0,\sigma_\epsilon^2)$ and $\mu \sim N(0,\sigma_\mu^2)$; $E(\epsilon_{hjt}\epsilon_{ijt})=0$ and $E(\mu_{hjt}\mu_{ijt})=0$ for $h \neq i$; $E(\epsilon_{ijt}\epsilon_{ikt})=0$ and $E(\mu_{ijt}\mu_{ikt})=0$ for

[11] The cross-sectional sample is heterogenous with respect to international operations, including firms with almost 100 years of experience of foreign operations as well as firms which are recently internationalized. The former group of firms has both extensive foreign production and exports in a wide range of countries. The standardization of the main variables is a crude way to account of these firm differences. One could also use domestic sales as a denominator instead of total sales, but some firms have almost no sales on the domestic market. This means that as domestic sales approach zero, the ratios of foreign production to domestic sales as well as parent exports to domestic sales go to infinity for some observations. These observations would then get a very large weight in the statistical estimations.

$j \neq k$.[12] However, $E(\epsilon_{ijt}\mu_{ijt}) \neq 0$, since these models are characterized by simultaneity. The decision to locate production is partly determined by the trade pattern of the firm.[13]

The method used is a variant of 2SLS with limited endogenous variables outlined in Nelson and Olson (1978). The structural form will only be estimated for equation (2), since the focus is on the effects of foreign production on exports. *NLS/TS* is characterized by a large share of zeroes (more than 60%). In the first stage of 2SLS, the reduced form of equation (1) is estimated by means of the "Tobit method" via maximum likelihood procedures, in order to create an instrument for *NLS/TS*.[14] Multiple regression is the appropriate statistical technique to estimate the structural form of equation (2) in the second stage of 2SLS. Here, the actual values of *NLS/TS* are replaced by the first-stage fitted values. The *Z*'s correspond to attributes of either the MNC or the host country. The latent variable, (*NLS/TS*)*, can be interpreted as an index of the intensity to produce abroad, of which *XF/TS* will be a function.

The estimation technique yields consistent parameter estimates, but the standard errors of the β's will be underestimated. In order to avoid this, the asymptotic variance-covariance matrix is derived and the standard errors are recalculated according to Amemiya (1979). We will also make a White (1980) test for heteroscedasticity. If such problems are present, White's (1980) consistent variance-covariance matrix will be estimated in addition to that of Amemiya (1979)

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[12] It should be noted that $E(\epsilon_{ijs}\epsilon_{ijt}) \neq 0$ and $E(\mu_{ijs}\mu_{ijt}) \neq 0$ for $s \neq t$. A firm which has a high intensity to export to a country at time *s*, is also expected to have a high intensity at time *t* as well. Although not taken into account of this in the estimation procedure, the possible autocorrelation will not yield inconsistent parameter estimates, but the efficiency of the parameter estimates will be reduced. In the model, we use unbalanced panel data for four time periods, i.e. it is far from always that a combination of a specific firm and country is included the maximum number of four 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 vectors of Z's, however, a lot of characteristics for individual firms as well as countries are included which partly capture fixed effects.

[13] The hypothesis of no simultaneity was tested, and rejected, using a Hausman (1978) test. Swedenborg used a simultaneous method in her (1979, 1982) studies, but Lipsey and Weiss (1984) never took the simultaneity into account.

[14] Estimating the reduced form is accomplished by regressing the dependent variable *NLS/TS* on all exogenous variables included in the system by means of the Tobit method.

above.[15] It is, however, not possible to calculate these both matrices at the same time.

It should be emphasized that it is important to include countries where production is zero in these models, because the left-out observations would otherwise be systematically excluded. Sample selection bias will be present and the parameter estimates will be both biased and inconsistent. Difficulties will also arise in the interpretation of what would have happened to exports if a firm had not established any production in a country.

In models (Ii) and (IIi), only countries where the firm has any production are considered. If the firm has no affiliate production, then parent exports of intermediate goods will also be zero. By definition, exports of inputs can only be directed to countries where the firm has production. By the same reason, no simultaneity will be present in these models. The dependent variable *XIL/TS* (or *XIX/TS*) includes a large share of zeroes (about 40%), i.e. affiliates in some host countries do not import any inputs at all from the parent. In model (Ii), only an export-equation will be specified where *XIL/TS* is a function of *NLS/TS* and *Z*'s, but the same specification is also used in model (IIi), where *XIX* and *NXS* are substituted for *XIL* and *NLS*, respectively:

$$\frac{XIL_{ijt}^{*}}{TS_{it}} = \gamma_0 + \gamma_1 \frac{NLS_{ijt}}{TS_{it}} + Z_3'\gamma + \eta_{ijt} , \qquad \textbf{(3a)}$$

$$\frac{XIL_{ijt}}{TS_{it}} = \begin{cases} \dfrac{XIL_{ijt}^{*}}{TS_{it}} & \text{if } \dfrac{XIL_{ijt}^{*}}{TS_{it}} > 0 \\ 0 & \text{if } \dfrac{XIL_{ijt}^{*}}{TS_{it}} \leq 0 \end{cases} . \qquad \textbf{(3b)}$$

The residuals are assumed to have the desired properties; $\eta \sim N(0,\sigma_\eta^2)$, $E(\eta_{hjt}\eta_{ijt})=0$ for $h \neq i$ and $E(\eta_{ijt}\eta_{ikt})=0$ for $j \neq k$, but $E(\eta_{ijs}\eta_{ijt}) \neq 0$ for $s \neq t$ (see note 12). Equation (3) will be estimated by means of the Tobit method via maximum likelihood

[15] White's (1980) test and correction for heteroscedasticity are not applicable for estimations with a censored dependent variable. This means that only the second step of models (If) and (IIf) are considered.

procedures.[16] $(XIL/TS)^*$ is a latent variable, which can be interpreted as an index of the intensity to import intermediate goods. The estimate of γ_1 may not be interpreted as a marginal effect in this model, however. The marginal effect of NLS/TS on XIL/TS must be calculated as described in McDonald and Moffitt (1980).[17]

Since the numerator is included in the denominator of the endogenous variables, the marginal effects in dollars of overseas production on exports can not be directly obtained from the basic estimations. The marginal effects on exports of finished goods, $\partial XF_j/\partial NLS_j$ and $\partial XTH_j/\partial NXS_j$, are obtained from equation (4), and on intermediate goods, $\partial XIL_j/\partial NLS_j$ and $\partial XIX_j/\partial NXS_j$, from equation (5) (derived in appendix B).[18]

$$\beta_1' = \frac{A + \beta_1}{1 - A}, \qquad \textbf{(4)}$$

$$\textit{where } A = \beta_0 + Z_2'\beta .$$

$$\gamma_1' = \frac{C + \gamma_1^m}{1 - C}, \qquad \textbf{(5)}$$

$$\textit{where } C = \gamma_0^m + Z_3'\gamma^m .$$

An m over the parameters in equation (5) indicates the marginal effect from the Tobit parameter estimate.

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[16] Swedenborg (1978, 1982) had the same sample criteria when estimating the effects on internal exports, but used a 2SLS estimation technique. The usage of OLS in the second stage will yield biased and inconsistent parameter estimates, however, since it does not take into account that many affiliates have no imports from the parent, i.e. that the dependent variable is censored.

[17] The parameter γ_1 is a marginal effect of NLS/TS on the latent variable $(XIL/TS)^*$. The marginal effect of NLS/TS on XIL/TS, $\partial E(XIL/TS)/\partial(NLS/TS)$, simply equals $F(z)\gamma_1$, where $F(z)$ is the cumulative normal distribution and $z = X'\gamma/\sigma_\eta$. X is a vector of explanatory variables and γ is the vector of estimated Tobit parameters. The z is calculated around the means of X.

[18] The interpretation of the marginal effects in dollars is necessary in order to make the substitution and complementary effects comparable.

5. Hypotheses for exogenous variables

Among the exogenous variables, factors derived from the OLI-theory (Dunning, 1981) which are expected to influence both foreign production and exports from the home country have been included. The OLI-theory states that the extent and pattern of international production is determined by three interrelated factors. The ownership (O) advantages (intangible assets, technology, human capital, scale economies, coordination abilities) explain why a firm has a competitive edge against foreign firms. If the firm finds it profitable to internalize (I) its assets rather than lease them to local firms, foreign production will take place.[19] Locational (L) advantages (market size, tariffs, distance, factor endowments) determine the location of production and trade flows. Given that L advantages favor production in a country, MNCs will undertake such production whenever, due to their O advantages, they are able to produce at lower costs than local firms. A necessary condition is that the O advantages must be relatively more mobile across countries within a firm than between firms. Since we focus on the demand side of the firm in each host country, the L factors included in the model are primarily those which affect the demand for the firm's products, but comparative advantages which influence the location of production are also of importance.[20] Most of the exogenous variables are known from earlier related studies, especially Swedenborg (1979, 1982). Table 3 depicts the exogenous variables included in each model and their expected impact on the endogenous variables.

The OLI-theory suggests that a firm which owns intangible assets has an absolute advantage over its competitors. To the extent that markets are imperfect for such assets, transaction costs and appropriability problems favor internalization. Firms based on intangible assets tend also to trade internally, i.e. a large trade of

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[19] Theoretically, it can be argued that licensing is an alternative to foreign production and exports; especially if entry barriers are present, the firm owning technology lacks some assets needed for FDI, or exports is not an available alternative. Licenses are, however, associated with asymmetrical information, high transaction costs and risks that the technology will leak from the licensee to unlicensed competitors, which means that licensing seldom occurs. In the case of Swedish MNCs in 1990, total incomes from external licenses were only 400 MSEK. This figure is negligible compared to total R&D expenditures, foreign production and parent exports, which were 25,000MSEK, 356,000 MSEK and 172,000MSEK, respectively.

[20] If we instead had analyzed how production abroad and at home affect each other on the supply side of the firm, irrespective of where the output is sold, then *only* comparative advantages which affect the location of production would have been included as L factors in the model.

intermediate goods between units of production is expected. R&D-intensity (RD_{it}), measured as total R&D expenditures divided by total sales of the firm, and average wage (LS_{it}) in the home country part of the firm, are used as indicators of firm-specific advantages. The former is expected to reflect the knowledge stock of the firm and the latter to be correlated with the quality of human capital within the company. Thus, both *RD* and *LS* should exert a positive impact on the intensities to export finished as well as intermediate goods, and to produce abroad.

Economies of scale at the plant level (SC_{it}) are assumed to award firms already in the market a competitive advantage. *SC* can be seen as high initial costs for new firms entering the market. Measured as average production in the foreign

Table 3. Survey of variables included in the respective models.

Model	(If)	(Ii)	(IIf)	(IIi)
Method	Simultane-ous Tobit	Tobit	Simultane-ous Tobit	Tobit
Countries	All countries		EC-countries	
Endogenous	*NLS*	*NLS*	*NXS*	*NXS*
Exogenous	*XF*	*XIL*	*XTH*	*XIX*
RD	1(+) 2(+)	3(+)	1(+) 2(+)	3(+)
LS	1(+) 2(+)	3(+)	1(+) 2(+)	3(+)
SC	1(+)		1(+)	
GDP	1(+) 2(+)			
GDPTH			1(+) 2(+)	
GDPCAP	1(?) 2(+)	3(+)	1(-)	3(+)
OPEN	1(-) 2(+)	3(+)		
DIST	1(-) 2(-)	3(-)	1(-)	3(-)
GERD	1(+)		1(+)	
RSET	1(+)		1(+)	

Note: A '1' indicates that the exogenous variable is included in equation (1), a '2' in equation (2) and a '3' in equation (3). The signs in the parentheses show the expected impact. *OPEN* is excluded when analyzing the EC-countries. In model (IIf), *GDPTH* (GDP in the third countries) is the only country variable included in equation (2), i.e. the export equation. There is no use to aggregate *GDPCAP*, *DIST* etc., for the rest of the region, since multicollinearity arises together with the time dummies. However, the country variables in the host country, where the production is located, are included in equation (1).

subsidiaries[21], *SC* is expected to have a positive influence on foreign production - especially production for export sales.

Some country variables representing L advantages are also included. The greater the total demand in the host country, measured as GDP (GDP_{jt}), the more exports of finished goods as well as production should be attracted, meaning that the coefficients for *GDP* are expected to be positive in both equation (1) and (2). Regarding production, this variable is also an indicator of economies to scale, which should strengthen the effect. *GDP* is not expected to have any influence on exports of intermediate goods, however, and is therefore excluded from equation (3). The income level of the host country, measured as GDP per capita ($GDPCAP_{jt}$), will influence exports and foreign production in two ways. First, high incomes mean high demand, which should have a positive effect on both endogenous variables. Second, one may expect income to be strongly correlated with the wage level, which would stimulate exports rather than foreign production, unless differences in wage levels across countries reflect differences in labor productivity. The effect on exports can clearly be expected to be positive, but the impact on foreign production is ambiguous and depends on which of the two factors mentioned above is the strongest. However, only the second effect is assumed to have any significance when producing for exports, since demand in the host country does not affect products which are exported to other countries.

An index measuring the host country trade policy used in Wheeler and Mody (1992) has been included ($OPEN_{jt}$).[22] This index will take on a higher value the more open the host country economy is. Openness is hypothesized to encourage exports at the expense of production within the host country. *OPEN* has a high variation across regions, but a small variation within a given region. This is the reason why *OPEN* is only included in model (I) when all countries are considered. Another index measures the physical distance between Sweden and the host country ($DIST_{jt}$). The higher the value of *DIST*, the lower the propensity to produce in, but

[21] It is presupposed that each subsidiary is operating at the optimal level of scale.

[22] The index includes limits on foreign ownership and government requirements that a certain percentage or specific type of local components be used when setting up manufacturing operations.

especially to export to the country.[23] Furthermore, two variables measuring the relative factor endowments of technology and skilled labor in the host country are included in order to take comparative advantages into account. These are defined as Gross domestic Expenditure on R&D as a percentage of GDP ($GERD_{jt}$) and the number of Research Scientists, Engineers and Technicians per 1000s of the population ($RSET_{jt}$) and are taken from UN (1992) statistics. Both *GERD* and *RSET* are expected primarily to attract production and are, therefore, only included in equation (1). These two host country variables correspond to the firm variables *RD* and *LS*.

There are, of course, other factors that affect the production and export patterns of MNCs. One of these is regional integration which gives rise to different trade-creating and trade-displacing effects: 1) for production plants within the region; and 2) for firms outside the region exporting to the region. Such a variable is, however, difficult to find an appropriate measure for. By including additive dummy variables over time and across regions, it is possible to partly control for this phenomenon in different regions over time.[24] We will also control for industry-specific fixed effects which may explain the variation between firms by assigning additive dummies for different industries.[25] This is necessary, since firms operating in industries that for example are dependent on natural resources in Sweden may be more willing to export rather than to produce abroad.

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[23] This variable takes both geographical and cultural/linguistic distance into account (Nordström, 1991). 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, other developed countries, and, finally, Latin America.

[24] The regions, included in model (I), are the EC, EFTA, North America (Nam), Latin America (Lam) and "Other countries". The last region includes Japan, India, Australia, New Zealand and South Africa. A dummy is also assigned to the countries within the EC which lie in the periphery of this region (Greece, Spain, Portugal, Italy and Ireland) from the Swedish point of view. In model (II), where the EC is analyzed, only the last dummy is included.

[25] Two variants of additive industry dummies are used: a) Dummies are assigned on a broad industry level on the 3-digit ISIC-level for engineering and on 2-digit level for the other industries; b) A finer industry classification into 32 groups on the 4-digit ISIC-level for engineering and 3-digit level for other industries. In both cases, the industry dummies will cover the whole sample. The treatment of engineering is due to that a majority of the Swedish MNCs belongs to this industry. Experiments were undertaken with firm-specific effects, but these resulted in multicollinearity between the firm dummies and the firm variables *RD*, *LS* and *SC*. This problem also arose when only the largest and most experienced MNCs were assigned firm dummies. The firm-specific effects were therefore replaced by industry dummies on a fine level, described above.

6. Empirical results

In all models, two variants were run, one with 10 industry dummies on a broad level (a) and another with 32 dummies on a fine level (b). The F-values and log likelihood ratios are satisfactorily high in all models, but the R^2 values, adjusted for degrees of freedoms, are relatively low. The latter is partly due to the fact that the endogenous variables are measured as intensities and not as absolute values. The recalculated parameter estimates for the main variables in models (I) and (II) are shown in Table 4 and 5, respectively.[26] The complete estimations for all exogenous variables are depicted in appendix C, Tables 8 and 9. The results for the exogenous variables are mixed. Mostly, the coefficients have the expected impact but they are not always significant.

Model (I)

As seen in Table 4, there is some evidence that an increase in foreign production exerts a negative impact on parent exports of finished goods, confirming our hypothesis of a substitution effect. The estimated derivative of *NLS* on *XF* is significant at the 5%-level in model (If-a) and at the 10%-level in model (If-b). When production for local sales in a certain country increases by \$100, the exports of finished goods to the same country decrease by \$9.6, with a 95% confidence interval of $\pm$\$7.6 in model (If-a), and -\$8.4 ($\pm$8.7) in model (If-b). A White (1980) test suggests that heteroscedasticity is present, but a separate estimation of the covariance matrix shows that the standard errors are lower than in the basic estimation where we have used Amemiya's (1979) method. The estimated parameters are, however, still consistent and the significance levels are not lowered.

In model (Ii), it is verified that increased foreign production spurs exports of intermediate goods from the parent. The estimated derivative of *NLS* on *XIL* is significant on the 1%-level in both runs. The complementary marginal effect is, however, not larger than \$3.9 ($\pm$1.1) and \$3.7 ($\pm$1.0) in models (Ii-a) and (Ii-b),

[26] It should be noted that the results are strictly applicable only to firms which are already well-established abroad, since the sample consists solely of MNCs.

Table 4. Estimated marginal effects for the main variables in model (I) and comparisons with previous studies.

Increase by $100 in affiliate production for		Marginal effect in $ on parent exports of		Net effect
		Finished goods (*XF*)	Intermediates (*XIL*)	
Local sales (*NLS*)	Model (I-a)	-9.63 ** (If-a) (3.85) [2.77]	3.89 *** (Ii-a) (0.58)	-5.74 (4.43)
	Model (I-b)	-8.36 * (If-b) (4.33) [3.57]	3.68 *** (Ii-b) (0.53)	-4.68 (4.86)
Swedenborg's results				
Increase by $100 in affiliate production for		Marginal effect in $ on parent		Net effect
		External exports	Internal exports	
Local sales	(1979)	-9 *	15 ***	6
	(1982)	-2	12 ***	10

Note: Standard errors in parentheses. Levels of significance are ***, ** and * significant at 1, 5 and 10 percent, respectively. In model (If), numbers in brackets are White (1980) heteroscedasticity consistent standard errors. Complete estimations of model (I) are shown in appendix C, Table 8.

respectively, when production for local sales increases by $100.

The net effect of model (I) is the sum of the effects in models (If) and (Ii): (a) -$9.6 + $3.9 = -$5.7 and (b) -$8.4 + $3.7 = -$4.7. This negative net effect is, however, never significant. The result that the net effect is insignificant is in line with Swedenborg (1979, 1982). She also found negative effects on external exports and positive effects on internal exports, but the positive net effect was not significant. The most striking difference in results between the present study and her studies is the impact on intermediates (model Ii) and internal exports. It is true that the dependent variables are measured in different ways, but the most reasonable explanation is that her model was mis-specified by using multiple regression in the second stage of 2SLS in spite of the fact that more than 40 percent of the observations were zeroes of the dependent variable.

Since the present study and those of Swedenborg use different time periods, we make an additional estimation where interaction time dummies are used for the

marginal effects of overseas production on parent exports.[27] We can then evaluate if the differences in the results can be attributed to some unobserved time trend. In appendix C Table 6, it seems to be a weak negative trend for the estimated marginal effect $\partial XF/\partial NLS$, but the interaction time dummies are not significant. The estimation of the marginal effect $\partial XIL/\partial NLS$ also indicate a negative trend. In this case, the 1990 estimate is significant different from the other time periods. The estimated marginal effects for the other three time periods are, however, not significantly different from each other. The latter trend that foreign affiliates have become less dependent of intermediates from the parent may be due to that takeovers have been more frequently used as entry mode during the last decades. Acquired firms tend to be less integrated with the parent than affiliates established through greenfield operations.

Model (II)

As the results of model (IIf) in Table 5 show, there is a strong negative effect in the rest of the region when the affiliates in a country produce for exports. The estimated derivative $\partial XTH/\partial NXS$ is significant at the 5%-level in both runs. The gross substitution effect is, in fact, as large as \$42.3 ($\pm$\$40.3) and \$43.0 ($\pm$37.8) in models (IIf-a) and (IIf-b), respectively, if the affiliates increase production for exports by \$100.[28] Production for export sales should also attract imports of intermediates to the host country, where production is located. The results verify that the estimated derivative of *NXS* on *XIX* is significant on the 1%-level in both runs. The complementary, marginal effect is estimated to \$4.9 ($\pm$\$1.2) in model (IIi-a) and \$4.8 ($\pm$\$1.1) in model (IIi-b).

The net effect of increasing affiliate exports by \$100 is the sum of these two effects: (a) -\$42.3 + \$4.9 = -\$37.4, and (b) -\$43.0 + \$4.8 = -\$38.2. The net effect is significant at the 10%-level and at the 5%-level, in the respective runs, and as hypothesized in section 3, this net effect is more negative than in model (I). It

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[27] Swedenborg used the 1974 survey in her (1979) study and the 1965, 1970, 1974 and 1978 surveys in her (1982) study.

[28] Also in this case, a White (1980) test shows that heteroscedasticity is present in equation (2). The heteroscedasticity consistent standard errors are similar to those of the basic estimation.

Table 5. Estimated marginal effects for the main variables in model (II).

Increase by $100 in affiliate production for		Marginal effect in $ on parent exports of		Net effect
		Finished goods (*XTH*)	Intermediates (*XIX*)	
Export sales (*NXS*)	Model (II-a)	-42.28** (IIf-a) (20.15) [20.28]	4.86*** (IIi-a) (0.60)	-37.42* (20.75)
	Model (II-b)	-43.03** (IIf-b) (18.88) [18.58]	4.85*** (IIi-b) (0.57)	-38.18** (19.45)

Note: Standard errors in parentheses. Levels of significance are ***, ** and * significant at 1, 5 and 10 percent, respectively. In model (IIf), numbers in brackets are White (1980) heteroscedasticity consistent standard errors. Complete estimations of model (II) are shown in appendix C, Table 9.

seems like Swedish MNCs locate production plants in the EC in order to serve the whole EC, instead of exporting from Sweden. It is not possible to compare the results of model (II) with other studies, since the impact of affiliate exports on parent exports to third countries has not been analyzed before. In appendix C Table 7, there is an additional estimation with interaction time dummies for the marginal effects of affiliate exports on parent exports. No time trend can, however, be found and the interaction time dummies are not significant.

The total net effect of affiliate production on parent exports in the EC is 0.69*(-)$4.7 + 0.31*(-)$38.2 = -$15.1. Here, the weights refer to the fact that, on average, 69 percent of net sales are local sales and 31 percent are exported. It is hardly probable that this aggregated effect is significant, however. It should also be noted that overseas production increases sales and market shares abroad for the firm, since the negative net effect on parent exports is much smaller than the increase of $100 in affiliate production. Finally, increased foreign production in the EC, on average, is trade-creating, although the net effect on parent exports is negative. The trade-creating effect is +$15.9 since affiliate exports increase by $31 while parent exports only decrease by $15.1.[29]

[29] The trade-creating effect of $15.9 is underestimated since we have not taken into account that some foreign affiliates export to the home country.

7. Concluding remarks

Using unique data on Swedish MNCs 1974-90, this chapter has analyzed how production in foreign subsidiaries affects parent exports. Two new methodological applications are introduced: 1) In order to avoid sample selection bias, all countries in which the firm has sales are included in the sample, not only those where affiliate production takes place; 2) Special care is taken to incorporate the effects of exports from affiliates to "third countries" on parent exports.

The results verify that increased foreign production substitutes parent exports of finished goods and complements parent exports of intermediates. In contrast to earlier empirical studies, the net effect is here found to be negative. The negative net effect is, however, never significant in the case of affiliate production for local sales. The evaluation of the operations in the EC, where production is particularly export oriented, suggests that exports from affiliates create a strong substitution effect in third countries. In this case, the negative net effect is significant.

Earlier empirical studies have not taken affiliate exports into account and only included countries where manufacturing affiliates have been located. This is likely to explain why only positive or non-negative relationships have been found. In addition, previous studies have been based on data from the 1960s and 1970s and it is possible that the behavior of MNCs may have changed during the last 25 years due to e.g. the increased reliance on takeover as mode of entry. In contrast to greenfield operations, acquired affiliates tend to be less integrated with the parent and, thus, attract less exports of intermediate products from the parent. The results suggest also that an expansion in overseas production increases foreign sales, and, in the EC, the impact on overall trade is positive, since the increase in affiliate exports is larger than the decrease in parent exports.

It should be noted that the results are valid only for firms which already have established production abroad, not for firms that are setting up a foreign affiliate for the first time. In the latter case, a common opinion is that foreign production may complement exports from the home country. This should be highly applicable in the Swedish case, where the limited domestic market induces firms to go abroad at an early stage of their life cycle. Furthermore, one should be careful when

drawing policy conclusions on the basis of the findings presented in this study, since we have not included any variables measuring restrictions on outward FDI in the models. Preventing expansion by firms abroad would mean that they would not be able to act in their own interest, hurting industry overall as well as the home economy. Still, this study points to the need of more detailed and careful evaluation in this area.

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Appendix A

Consider the following definitions of export and affiliate production variables:

NLS_{ij} = Net Local Sales. Local sales in country j of firm i's affiliates in the same country less the part of these sales which is imported from the home country. When subtracting, the affiliate's imports of all finished goods are assumed to consist of sales on the local market, while imports of intermediate goods are proportionally shared between *NLS* and *NXS*.

NXS_{ij} = Net Export Sales. Export sales to other countries than j from firm i's affiliates in country j less the part of these sales which is imported from the home country. All exports to the home country are excluded.

NS_{ij} = Net Sales. Total sales of firm i's affiliates in country j less affiliate imports from the parent company. All sales to the home country are excluded.

By definition:

$$NS_{ij} \equiv NLS_{ij} + NXS_{ij} .$$

XF_{ij} = Parent exports of finished goods of firm i to country j.

XIL_{ij} = Parent exports of intermediate goods of firm i to country j. Only intermediate goods used in production for local sales are included.

XIX_{ij} = Parent exports of firm i to country j for sales in other countries than j. Only intermediate goods used in production for export sales are included. If the affiliate has no export sales, *XIX* is zero.

XTH_{ij} = Parent exports of finished goods of firm i to countries other than j in the rest of the region, i.e. to 'third countries'.

XP_{ij} = Total parent exports of firm i to country j.

By definition:

$$XP_{ij} \equiv XF_{ij} + XIL_{ij} + XIX_{ij} .$$

Appendix B

Derivations of marginal effects and standard errors

The marginal effect of an increase in foreign production in country j, NLS_j and NXS_j, on parent exports of finished goods, XF_j and XTH_j, respectively, in equation (2) can be derived by first dividing total sales, TS, into foreign production, NS, parent exports, XP, and domestic sales, DS:

$$\frac{XF_j}{\sum_{l=0,\, l\neq j}^{L} NS_l + NLS_j + NXS_j + \sum_{l=0,\, l\neq j}^{L} XP_l + XF_j + XIL_j + XIX_j + DS} = A + \beta_1 \frac{NLS_j}{\sum_{l=0,\, l\neq j}^{L} NS_l + NLS_j + NXS_j + \sum_{l=0,\, l\neq j}^{L} XP_l + XF_j + XIL_j + XIX_j + DS}, \quad (6)$$

where $A = \beta_0 + Z_2'\beta$,

$$TS = \sum_{l=0,\, l\neq j}^{L} NS_l + NLS_j + NXS_j + \sum_{l=0,\, l\neq j}^{L} XP_l + XF_j + XIL_j + XIX_j + DS .$$

After that one solves for XF_j (and XTH_j):

$$XF_j = \frac{A}{1-A}\left(\sum_{l=0,\, l\neq j}^{L} NS_l + NLS_j + NXS_j + \sum_{l=0,\, l\neq j}^{L} XP_l + XIL_j + XIX_j + DS\right) + \frac{\beta_1 NLS_j}{1-A} . \quad (7)$$

This gives the partial derivative $\partial XF_j/\partial NLS_j$:

$$\beta_1' = \frac{\partial XF_j}{\partial NLS_j} = \frac{A + \beta_1}{1 - A}, \quad (8)$$

which is calculated in the same way for $\partial XTH_j/\partial NXS_j$.

In a similar manner, the marginal effect of foreign production, NLS_j and NXS_j, on parent exports of intermediate products, XIL_j and XIX_j, respectively, in equation (3) can be derived:

$$\gamma'_1 = \frac{\partial XIL_j}{\partial NLS_j} = \frac{C + \gamma_1^m}{1 - C} , \tag{9}$$

where $C = \gamma_0^m + Z_3'\gamma^m$.

An m over the parameter estimates indicates the marginal effect from the Tobit estimate. A and C are calculated around the means of Z_2 and Z_3.

The standard error of β'_1 is calculated, using a first-order linear approximation, according to Blom (1980):

$$\sigma_{\beta'_1} = \sqrt{Var\left(\frac{A + \beta_1}{1 - A}\right)} = \sqrt{Var\ (g\ (\beta_0, \beta_1, ..., \beta_k))} \tag{10}$$

$$= \sqrt{\sum_{i=0}^{k} Var(\beta_i)\left(\frac{\partial g}{\partial \beta_i}\right)^2 + 2\sum_{i=0,\, i<j}^{k} Cov(\beta_i, \beta_j)\left(\frac{\partial g}{\partial \beta_i}\right)\left(\frac{\partial g}{\partial \beta_j}\right)} ,$$

where

$$\frac{\partial g}{\partial \beta_1} = \frac{1}{1 - A} ,$$

$$\left.\frac{\partial g}{\partial \beta_i}\right|_{i \neq 1} = \frac{1 + \beta_1}{(1 - A)^2} X_i .$$

The standard error of γ'_1 is calculated in a similar manner:

$$\sigma_{\gamma'_1} = \sqrt{\sum_{i=0}^{k} Var(\gamma_i)\left(\frac{\partial h}{\partial \gamma_i}\right)^2 + 2\sum_{i=0,\, i<j}^{k} Cov(\gamma_i, \gamma_j)\left(\frac{\partial h}{\partial \gamma_i}\right)\left(\frac{\partial h}{\partial \gamma_j}\right)} , \tag{11}$$

where

$$h = h(\gamma_0, \gamma_1, ..., \gamma_k) \ ,$$

$$\frac{\partial h}{\partial \gamma_1} = \frac{1}{1 - C} \ ,$$

$$\left.\frac{\partial h}{\partial \gamma_i}\right|_{i \neq 1} = \frac{1 + \gamma_1}{(1 - C)^2} X_i \ .$$

Point estimate and standard error of the net effects

With the following null-hypothesis, it is possible to test if the net effect, $\beta'_1+\gamma'_1$, is significant:

$$H_0 : \frac{\beta'_1 + \gamma'_1}{\sigma_{(\beta'_1 + \gamma'_1)}} = 0 \ , \qquad (12)$$

Reject H_0 *if t-statistics* $> |2|$,

where

$$\sigma_{(\beta'_1 + \gamma'_1)} = \sqrt{Var(\beta'_1) + Var(\gamma'_1) + 2\, Cov(\beta'_1, \gamma'_1)} \ . \qquad (13)$$

The covariance is unknown, since the parameter estimates come from samples with different sizes. The small sample is included in the large sample, which means that β'_1 and γ'_1 should not be uncorrelated. It is, however, possible to calculate the limits of this covariance, since we know from simple correlation that:

$$-\sigma_{\beta'_1}\sigma_{\gamma'_1} \leq Cov(\beta'_1, \gamma'_1) \leq \sigma_{\beta'_1}\sigma_{\gamma'_1} \ .$$

The highest possible covariance is used, i.e. $\sigma_{\beta'1}\sigma_{\gamma'1}$, in order to be sure not to reject a true null-hypothesis.

Appendix C

Table 6. Estimation of interaction dummies and marginal effects for different time periods in Model (I). Reference period = 1990.

	Model (If-b)		Model (Ii-b)	
Interaction dummies	Marginal effect on *XF*	Std. error	Marginal effect on *XIL*	Std. error
NLS	-0.102***	0.036	0.017**	8.13 E-3
Interaction dummy 1974	0.027	0.038	0.048**	0.024
Interaction dummy 1978	0.023	0.033	0.032*	0.019
Interaction dummy 1986	0.011	0.037	0.032***	0.014
Time period	*∂XF/∂NLS*	Std. error	*∂XIL/∂NLS*	Std. error
1974	-0.075*	0.044	0.065***	0.022
1978	-0.080*	0.042	0.049***	0.016
1986	-0.091***	0.033	0.049***	7.32 E-3
1990	-0.102***	0.036	0.017**	8.13 E-3

Note: Levels of significance are ***, ** and * significant at 1, 5 and 10 percent respectively.

Table 7. Estimation of interaction dummies and marginal effects for different time periods in Model (II). Reference period = 1990.

	Model (IIf-b)		Model (IIi-b)	
Interaction dummies	Marginal effect on *XTH*	Std. error	Marginal effect on *XIX*	Std. error
NXS	-0.568***	0.167	0.047***	7.05 E-3
Interaction dummy 1974	0.120	0.292	5.90 E-3	0.021
Interaction dummy 1978	-0.186	0.264	-0.012	0.018
Interaction dummy 1986	-0.067	0.229	0.011	0.014
Time period	*∂XTH/∂NXS*	Std. error	*∂XIX/∂NXS*	Std. error
1974	-0.448	0.289	0.053***	0.019
1978	-0.754***	0.256	0.035**	0.017
1986	-0.634***	0.213	0.058***	0.012
1990	-0.568***	0.167	0.047***	7.05 E-3

Note: Levels of significance are ***, ** and * significant at 1, 5 and 10 percent respectively.

Table 8. Estimation results of model (I).

Method	Simultaneous Tobit method		Tobit method	
Dependent variables	*XF/TS*		*XIL/TS*	
Explanatory variables	(If-a)	(If-b)	(Ii-a)	(Ii-b)
$\widehat{NLS/TS}$	-0.107***	-0.095**	—	—
	(0.036)	(0.041)		
	[0.026]	[0.034]		
NLS/TS	—	—	0.063***	0.059***
			(9.05 E-3)	(8.32 E-3)
RD	0.016	0.039	0.095***	0.043
	(0.018)	(0.030)	(0.023)	(0.038)
	[0.014]	[0.027]		
LS	5.16 E-5	-4.37 E-5	-9.24 E-6	-9.03 E-5
	(5.42 E-5)	(5.72 E-5)	(5.53 E-5)	(5.50 E-5)
	[5.29 E-5]	[6.09 E-5]		
GDP	5.34 E-6 ***	5.21 E-6 ***	—	—
	(5.42 E-7)	(5.80 E-7)		
	[5.97 E-7]	[6.49 E-7]		
GDPCAP	9.26 E-8	2.78 E-8	1.12 E-7	1.23 E-7
	(8.09 E-8)	(9.18 E-8)	(1.13 E-7)	(1.01 E-7)
	[6.85 E-8]	[7.65 E-8]		
DIST	-8.19 E-4 ***	-7.73 E-4 ***	-4.22 E-5	-1.00 E-4
	(8.93 E-5)	(9.60 E-5)	(8.60 E-5)	(7.69 E-5)
	[7.17 E-5]	[8.32 E-5]		
OPEN	-1.88 E-3 **	-2.32 E-3 ***	1.54 E-3 **	9.43 E-4
	(7.44 E-4)	(7.97 E-4)	(9.42 E-4)	(8.54 E-4)
	[4.69 E-4]	[5.33 E-4]		
F-value	31.0	17.1	—	—
Adjusted R^2	0.17	0.17	—	—
Log likelihood ratio	—	—	531.0	716.3
No. of observations	3524	3524	1057	1057
Left censored obs.	—	—	452	452

Note: The numbers in parentheses are standard errors. Levels of significance are ***, ** and * significant at 1, 5 and 10 percent respectively. In model (If), numbers in brackets are White (1980) heteroscedasticity consistent standard errors. First-stage estimates of model (If) are shown in Table 10. Intercepts and dummies for time periods, regions and industries in models (If-a) and (Ii-a) are shown in Table 11, and in models (If-b) and (Ii-b) in Table 12.

Table 9. Estimation results of model (II).

Method	Simultaneous Tobit method		Tobit method	
Dependent variables	*XTH/TS*		*XIX/TS*	
Explanatory variables	(IIf-a)	(IIf-b)	(IIi-a)	(IIi-b)
$\widehat{NXS/TS}$	-0.494 ***	-0.500 ***	—	—
	(0.172)	(0.161)		
	[0.181]	[0.168]		
NXS/TS	—	—	0.088 ***	0.087 ***
			(0.011)	(0.010)
RD	0.380 ***	0.843 ***	0.052 ***	0.096 ***
	(0.090)	(0.140)	(0.019)	(0.033)
	[0.076]	[0.121]		
LS	1.88 E-4	1.10 E-5	6.16 E-5	5.71 E-5
	(2.29 E-4)	(2.24 E-4)	(4.50 E-5)	(4.40 E-5)
	[2.74 E-4]	[3.07 E-4]		
GDPTH	9.84 E-7	6.28 E-7	—	—
	(3.65 E-6)	(3.50 E-6)		
	[3.68 E-6]	[3.52 E-6]		
GDPCAP	—	—	-1.21 E-7	-8.28 E-8
			(1.07 E-7)	(9.64 E-8)
DIST	—	—	-4.35 E-5	-2.96 E-5
			(5.31 E-5)	(4.81 E-5)
F-value	41.53	25.13	—	—
Adjusted R^2	0.28	0.34	—	—
Log likelihood test	—	—	503.2	540.4
No. of observations	1642	1642	407	407
Left censored obs.	—	—	172	172

Note: The numbers in parentheses are standard errors. Levels of significance are ***, ** and * significant at 1, 5 and 10 percent respectively. In model (IIf), numbers in brackets are White (1980) heteroscedasticity consistent standard errors. First-stage estimates of model (IIf) are shown in Table 13. Intercepts and dummies for time periods, regions and industries in models (IIf-a) and (IIi-a) are shown in Table 14, and in models (IIf-b) and (IIi-b) in Table 15.

Table 10. First-stage estimates of model (If).

Method	Tobit	
Dependent variables	*NLS/TS*	
Explanatory variables	(If-a)	(If-b)
RD	-0.165 ** (0.068)	-0.039 (0.118)
LS	7.98 E-4 *** (1.67 E-4)	8.11 E-4 *** (1.86 E-4)
SC	3.08 E-5 *** (4.62 E-6)	3.03 E-5 *** (5.55 E-6)
GDP	7.91 E-6 *** (1.72 E-6)	7.75 E-6 *** (1.81 E-6)
GDPCAP	-4.60 E-7 (3.66 E-7)	-3.91 E-7 (3.68 E-7)
DIST	-2.03 E-3 *** (2.44 E-4)	-2.05 E-3 *** (2.59 E-4)
OPEN	-9.98 E-3 *** (2.89 E-3)	-0.010 *** (2.92 E-3)
RSET	4.76 E-3 ** (2.34 E-3)	4.33 E-3 * (2.33 E-3)
GERD	0.011 ** (5.33 E-3)	0.012 * (5.93 E-3)
Log likelihood ratio No. of observations Left censored obs.	— 3524 1093	— 3524 1093

Note: The numbers in parentheses are standard errors. Levels of significance are ***, ** and * significant at 1, 5 and 10 percent respectively. Intercepts and dummies for time periods, regions and industries in models (If-a) and (If-b) are shown in Tables 11 and 12, respectively.

Table 11. Supplement to Tables 8 and 10. Intercepts and dummies for time periods, regions and industries in models (If-a) and (Ii-a).

Method	OLS (Second-stage)		Tobit (First-stage)		Tobit	
Dependent variables	*XF/TS*		*NLS/TS*		*XIL/TS*	
Explanatory variables	Model (If-a)		Model (If-a)		Model (Ii-a)	
	Parameter	Std. error	Parameter	Std. error	Parameter	Std. error
Intercept	0.044 ***	7.14 E-3	0.016	0.028	-0.018 *	9.94 E-3
Time dummy 1978	1.65 E-3	1.94 E-3	-0.014 **	6.68 E-3	-1.40 E-3	2.09 E-3
Time dummy 1986	1.34 E-3	1.86 E-3	-9.56 E-3	6.64 E-3	-3.21 E-3	2.01 E-3
Time dummy 1990	-8.73 E-4	2.26 E-3	-0.017 **	7.74 E-3	-5.06 E-3 **	2.42 E-3
Dummy EC-perifery	-2.88 E-4	1.94 E-3	7.43 E-3	8.60 E-3	-5.39 E-4	3.08 E-3
Dummy EFTA	-0.015 ***	2.57 E-3	-0.054 ***	7.20 E-3	-3.68 E-3	2.47 E-3
Dummy Nam	-0.026 ***	3.01 E-3	-0.028 ***	0.011	3.01 E-3	2.74 E-3
Dummy Lam	0.017 ***	4.77 E-3	0.069 ***	0.016	0.011 *	6.50 E-3
Dummy Other	-8.24 E-3 ***	2.62 E-3	-0.032 ***	0.010	7.01 E-3	3.85 E-3
Industry dummy 1	-8.76 E-3 ***	2.98 E-3	-0.015	0.012	-0.017 ***	5.25 E-3
Industry dummy 2	0.010 ***	3.23 E-3	-0.039 ***	0.013	0.015 ***	5.06 E-3
Industry dummy 3	-7.54 E-3 **	3.09 E-3	0.034 ***	9.71 E-3	-7.04 E-3 **	3.24 E-3
Industry dummy 4	-9.19 E-4	1.70 E-3	0.011 *	6.32 E-3	-7.93 E-3 ***	2.17 E-3
Industry dummy 5	1.46 E-3	1.49 E-3	-8.45 E-3	5.86 E-3	-1.93 E-3	1.81 E-3
Industry dummy 6	-8.96 E-4	2.26 E-3	0.029 ***	6.57 E-3	4.39 E-3 **	2.04 E-3
Industry dummy 7	3.45 E-4	2.34 E-3	-0.020 **	9.43 E-3	8.08 E-4	2.95 E-3
Industry dummy 8	7.56 E-3	2.03 E-3	-0.011	7.85 E-3	2.71 E-3	2.70 E-3
Industry dummy 9	7.49 E-3	2.48 E-3	0.010	9.06 E-3	0.015 ***	3.14 E-3

Note: ***, ** and * indicate significance at 1, 5 and 10 percent respectively.

Table 12. Supplement to Tables 8 and 10. Intercepts and dummies for time periods, regions and industries in models (If-b) and (Ii-b).

Method	OLS (Second-stage)		Tobit (First-stage)		Tobit	
Dependent variables	*XF/TS*		*NLS/TS*		*XIL/TS*	
Explanatory variables	Model (If-b)		Model (If-b)		Model (Ii-b)	
	Parameter	Std. error	Parameter	Std. error	Parameter	Std. error
Intercept	0.049***	7.81 E-3	0.034	0.030	-9.89 E-3	9.05 E-3
Time dummy 1978	2.99 E-3	1.97 E-3	-0.011	6.94 E-3	-3.62 E-4	1.94 E-3
Time dummy 1986	2.16 E-3	1.92 E-3	-9.95 E-3	6.93 E-3	-9.29 E-4	1.94 E-3
Time dummy 1990	6.15 E-4	2.28 E-3	-0.014*	8.04 E-3	-3.28 E-3	2.36 E-3
Dummy EC-perifery	-6.24 E-3 ***	2.37 E-3	1.80 E-3	0.011	1.20 E-3	2.77 E-3
Dummy EFTA	-0.015***	2.85 E-3	-0.057***	7.26 E-3	-2.95 E-3	2.23 E-3
Dummy Nam	-0.027***	3.17 E-3	-0.030***	0.012	2.58 E-3	2.47 E-3
Dummy Lam	9.26 E-3 *	5.28 E-3	0.063***	0.020	0.012*	5.87 E-3
Dummy Other	-0.010***	3.03 E-3	-0.036***	0.012	5.79 E-3 *	3.45 E-3
Industry dummy 1	9.03 E-3 **	3.87 E-3	0.010	0.014	8.29 E-3 **	3.31 E-3
Industry dummy 2	5.18 E-4	3.67 E-3	-0.029**	0.014	-9.79 E-4	4.35 E-3
Industry dummy 3	4.79 E-3	3.01 E-3	-0.034***	0.010	6.79 E-3 **	2.96 E-3
Industry dummy 4	5.78 E-3 **	2.75 E-3	-0.015	9.92 E-3	4.74 E-3 *	2.43 E-3
Industry dummy 5	2.62 E-3	4.15 E-3	-0.054***	0.015	-1.21 E-4	4.91 E-3
Industry dummy 6	2.97 E-3	2.80 E-3	-0.028***	0.011	-3.53 E-5	2.76 E-3
Industry dummy 7	2.28 E-3	3.88 E-3	-2.72 E-3	0.014	6.45 E-3 **	3.21 E-3
Industry dummy 8	-1.01 E-3	4.41 E-3	-0.013	0.017	5.21 E-3	4.14 E-3
Industry dummy 9	4.65 E-4	4.17 E-3	0.041***	0.012	-3.62 E-3	3.23 E-3
Industry dummy 10	2.21 E-3	3.22 E-3	0.011	0.012	0.011***	2.91 E-3
Industry dummy 11	1.23 E-3	3.37 E-3	-0.036***	0.013	5.59 E-3 *	3.30 E-3
Industry dummy 12	7.26 E-3	5.39 E-3	-0.053**	0.022	2.68 E-3	9.56 E-3
Industry dummy 13	-1.31 E-3	5.30 E-3	-0.024	0.022	0.036***	7.18 E-3
Industry dummy 14	2.40 E-3	3.67 E-3	-0.018	0.014	-3.08 E-3	4.75 E-3
Industry dummy 15	-2.00 E-3	5.74 E-3	-0.064***	0.024	8.17 E-3	9.79 E-3
Industry dummy 16	-2.32 E-3	3.93 E-3	0.011	0.014	-1.39 E-3	3.70 E-3
Industry dummy 17	0.011***	3.29 E-3	-0.037***	0.012	3.50 E-3	3.21 E-3
Industry dummy 18	0.010***	3.38 E-3	-0.012	0.012	4.18 E-3	3.40 E-3
Industry dummy 19	-4.60 E-3	3.53 E-3	0.023*	0.012	-5.74 E-3 *	3.21 E-3
Industry dummy 20	2.00 E-3	3.63 E-3	0.028**	0.012	-8.05 E-3 **	3.19 E-3
Industry dummy 21	1.15 E-3	3.76 E-3	0.015	0.014	-0.022***	6.00 E-3
Industry dummy 22	-3.01 E-4	4.71 E-3	-0.023	0.018	4.87 E-3	5.15 E-3
Industry dummy 23	1.99 E-3	7.97 E-3	-0.093***	0.033	7.39 E-3	0.012
Industry dummy 24	-1.74 E-3	3.78 E-3	-0.044***	0.014	-1.24 E-3	4.28 E-3
Industry dummy 25	6.55 E-3 *	3.84 E-3	-4.42 E-3	0.015	-0.011**	4.95 E-3
Industry dummy 26	0.010***	3.04 E-3	-5.64 E-3	0.011	0.017***	3.03 E-3
Industry dummy 27	-5.42 E-3	3.71 E-3	-0.026*	0.014	-0.018***	5.67 E-3
Industry dummy 28	-7.67 E-3	9.46 E-3	-0.059	0.044	0.014	0.015
Industry dummy 29	-1.47 E-3	8.99 E-3	-0.071*	0.041	0.178***	0.015
Industry dummy 30	0.015***	4.29 E-3	-0.052***	0.015	2.45 E-3	5.17 E-3
Industry dummy 31	0.015*	8.33 E-3	-0.042	0.039	-0.051 E-3	0.122

Note: ***, ** and * indicate significance at 1, 5 and 10 percent respectively.

Table 13. First-stage estimates of model (IIf).

Method	Tobit	
Dependent variables	*NXS/TS*	
Explanatory variables	(IIf-a)	(IIf-b)
RD	-0.081 (0.070)	0.162 (0.114)
LS	6.44 E-4 *** (1.68 E-4)	6.63 E-4 *** (1.85 E-4)
SC	2.35 E-6 (3.57 E-6)	7.02 E-6 (4.63 E-6)
GDPTH	7.08 E-6 (5.72 E-6)	7.21 E-6 (5.70 E-6)
GDPCAP	1.76 E-6 *** (4.66 E-7)	1.78 E-6 *** (4.64 E-7)
DIST	-1.37 E-4 (2.06 E-4)	-1.44 E-4 (2.06 E-4)
RSET	-2.41 E-3 (2.36 E-3)	-2.52 E-3 (2.35 E-3)
GERD	0.021 *** (6.80 E-3)	0.021 *** (6.78 E-3)
Log likelihood ratio	—	—
No. of observations	1642	1642
Left censored obs.	422	422

Note: The numbers in parentheses are standard errors. Levels of significance are ***, ** and * significant at 1, 5 and 10 percent respectively. Intercepts and dummies for time periods, regions and industries in models (IIf-a) and (IIf-b) are shown in Tables 14 and 15, respectively.

Table 14. Supplement to Tables 9 and 13. Intercepts and dummies for time periods, regions and industries in models (IIf-a) and (IIi-a).

Method	OLS (Second-stage)		Tobit (First-stage)		Tobit	
Dependent variables	*XTH/TS*		*NXS/TS*		*XIX/TS*	
Explanatory variables	Model (IIf-a)		Model (IIf-a)		Model (IIi-a)	
	Parameter	Std. error	Parameter	Std. error	Parameter	Std. error
Intercept	0.054***	0.019	-0.016***	0.041	-2.54 E-3	3.80 E-3
Time dummy 1978	0.030***	0.010	-0.043***	0.013	-8.24 E-4	1.80 E-3
Time dummy 1986	0.034***	0.010	-0.035***	0.013	-2.28 E-3	1.59 E-3
Time dummy 1990	0.036***	0.017	-0.075**	0.030	-3.33 E-3	2.04 E-3
Dummy EC-periphery	—	—	0.023**	0.010	-1.80 E-3	1.95 E-3
Industry dummy 1	-0.057***	0.014	-0.012	0.012	-7.22 E-3	4.96 E-3
Industry dummy 2	-0.010	0.020	-0.067***	0.021	0.076***	8.48 E-3
Industry dummy 3	-0.064***	0.014	0.012	9.86 E-3	-8.79 E-3 **	3.63 E-3
Industry dummy 4	-0.020**	7.95 E-3	-1.70 E-3	6.47 E-3	-2.31 E-3	1.82 E-3
Industry dummy 5	0.024***	7.51 E-3	0.016***	5.40 E-3	-1.01 E-3	1.44 E-3
Industry dummy 6	-0.044***	9.34 E-3	0.017***	6.50 E-3	9.88 E-4	1.62 E-3
Industry dummy 7	0.016	0.012	0.011	9.01 E-3	0.016***	2.27 E-3
Industry dummy 8	0.161***	9.38 E-3	3.64 E-3	9.13 E-3	1.41 E-3	1.88 E-3
Industry dummy 9	0.081***	0.012	-0.020*	0.010	4.44 E-3	2.76 E-3

Note: ***, ** and * indicate significance at 1, 5 and 10 percent respectively.

Table 15. Supplement to Tables 9 and 13. Intercepts and dummies for time periods, regions and industries in models (IIf-b) and (IIi-b).

Method	OLS (Second-stage)		Tobit (First-stage)		Tobit	
Dependent variables	*XTH/TS*		*NXS/TS*		*XIX/TS*	
Explanatory variables	Model (IIf-b)		Model (IIf-b)		Model (IIi-b)	
	Parameter	Std. error	Parameter	Std. error	Parameter	Std. error
Intercept	0.052***	0.020	-0.159***	0.041	-3.46 E-3	3.88 E-3
Time dummy 1978	0.022**	9.91 E-3	-0.043***	0.013	-1.98 E-3	1.68 E-3
Time dummy 1986	0.028***	0.010	-0.036***	0.014	-4.77 E-3 ***	1.60 E-3
Time dummy 1990	0.027	0.017	-0.075**	0.030	-5.20 E-3 ***	1.98 E-3
Dummy EC-periphery	—	—	0.023**	0.010	-1.09 E-3	1.77 E-3
Industry dummy 1	0.010	0.018	0.012	0.014	1.70 E-3	2.84 E-3
Industry dummy 2	0.030**	0.015	4.96 E-3	0.012	4.76 E-3 *	2.77 E-3
Industry dummy 3	0.034***	0.012	-0.012	9.68 E-3	2.53 E-3	2.48 E-3
Industry dummy 4	0.054***	0.013	-0.015	9.49 E-3	-8.77 E-4	2.13 E-3
Industry dummy 5	0.053***	0.015	0.018*	0.013	3.47 E-3	3.18 E-3
Industry dummy 6	-1.98 E-3	0.013	0.012	9.72 E-3	-1.55 E-3	2.26 E-3
Industry dummy 7	0.035*	0.020	2.39 E-3	0.015	1.96 E-3	3.02 E-3
Industry dummy 8	-0.079***	0.021	0.20	0.016	-2.27 E-3	3.60 E-3
Industry dummy 9	-0.042**	0.018	0.039***	0.012	3.88 E-3	2.63 E-3
Industry dummy 10	-0.019	0.021	-0.010	0.012	-9.27 E-4	2.76 E-3
Industry dummy 11	-2.57	0.016	8.29 E-3	0.012	0.018***	2.81 E-3
Industry dummy 12	0.076***	0.022	4.05 E-3	0.018	1.26 E-3	4.92 E-3
Industry dummy 13	-1.44 E-3	0.025	-0.019	0.023	-0.013	0.017
Industry dummy 14	-0.022	0.015	-0.038***	0.014	-3.31 E-3	5.06 E-3
Industry dummy 15	-0.013	0.020	2.68 E-3	0.015	1.10 E-3	3.37 E-3
Industry dummy 16	0.187***	0.014	-0.015	0.013	4.88 E-3 *	2.63 E-3
Industry dummy 17	0.169***	0.015	-6.57 E-3	0.015	1.57 E-3	2.61 E-3
Industry dummy 18	-0.043***	0.016	9.00 E-3	0.012	-4.57 E-3	3.32 E-3
Industry dummy 19	-0.072***	0.017	-5.83 E-3	0.013	-2.32 E-3	3.04 E-3
Industry dummy 20	-0.053***	0.017	-7.88 E-3	0.014	-5.35 E-3	4.07 E-3
Industry dummy 21	-0.064***	0.021	9.18 E-4	0.017	-7.45 E-3 *	4.43 E-3
Industry dummy 22	0.048*	0.028	-0.071**	0.030	0.021***	7.75 E-3
Industry dummy 23	3.19 E-3	0.015	-0.022	0.013	-5.21 E-4	3.59 E-3
Industry dummy 24	0.095***	0.018	0.021	0.013	1.78 E-3	3.59 E-3
Industry dummy 25	0.094***	0.014	-0.026**	0.012	5.01 E-3 *	2.81 E-3
Industry dummy 26	-0.038**	0.016	-0.020	0.014	-0.010	7.55 E-3
Industry dummy 27	-0.048	0.012	-5.54 E-3	0.032	8.60 E-3	7.69 E-3
Industry dummy 28	7.73 E-3	0.021	-0.073	0.022	0.077***	7.70 E-3

Note: ***, ** and * indicate significance at 1, 5 and 10 percent respectively.

Chapter V

The Simultaneous Relationship between R&D and Foreign Sales*

1. Introduction

Multinational corporations (MNCs) account for an increasing share of the world's industrial research and development (R&D), and dominate in terms of aggregate manufacturing exports and output as well. In small open economies like Sweden, the Netherlands or Canada, where industrial firms are highly dependent on foreign markets, MNCs play a pronounced role. In 1990, for example, Sweden based MNCs accounted for 83% of aggregated Swedish industrial R&D, 52% of exports, and 40% of industrial production. For the same year more than 80% of the Swedish MNCs' R&D was centralized at home, while only 20% of their sales were in Sweden. It is clear that technology generated at home is to a large extent exploited abroad. In the case of Sweden, it has been argued that foreign direct investment (FDI) has enabled the MNCs to grow larger and spend more resources on R&D at home, then would otherwise be the case, and that this has had a positive impact on Sweden's technological base (Håkansson, 1980; Swedenborg, 1982). This point has also been discussed in the Canadian context by Globerman (1994).

The present study analyzes the simultaneous relationship between MNCs' level of R&D and their foreign sales.[1] First, it is proposed that firms with higher R&D outlays should gain a technological advantage relative to competitors, and *ceteris paribus* that such firms should be more successful in penetrating foreign

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* This paper is jointly written with Gunnar Fors, IUI.

[1] A firm's foreign sales is here measured as the sum of production in foreign affiliates and parent company exports.

markets. Second, larger foreign sales should in turn facilitate further investments in fixed costs such as R&D, since the created knowledge can be exploited to a higher degree, leading to an increased rate of return on each R&D dollar spent. Highly internationalized firms may thus achieve economies of scale in the *use* of their technology. These arguments especially apply to MNCs from small countries with limited growth potential in their domestic markets. Success abroad should also generate profits that enable internal financing of new R&D projects, and at a cheaper rate than external funds.

The two-way relationship has theoretically been pointed out by Caves (1996) in the case of MNCs. More generally, Grossman and Helpman (1991) also argue that there can be endogenous effects between innovation and trade. The only previous empirical study analyzing the two-way relationship between R&D and foreign sales (Hirschey, 1981) used data on MNCs from the United States, a country with a large domestic market. However, Hirschey only found evidence of an impact of foreign sales on R&D. In the present study, firms originating from a small country are considered. The analysis is based on detailed firm-level data covering practically all Swedish MNCs in manufacturing in 1986 and 1990. Our empirical results suggest a significant impact in both directions.

Theoretical aspects and previous empirical literature regarding R&D and foreign operations are discussed in section 2. The data base and the econometric specification are described in section 3. In section 4, the exogenous variables are introduced. The empirical results are presented in section 5, and the final section concludes.

2. Theoretical background and earlier empirical studies

Possession of oligopolistic advantages is generally argued to be required before a firm is able to penetrate foreign markets (e.g. Hymer, 1960; Caves 1971). Such advantages are considered necessary to offset the excessive costs of setting up and operating affiliates across geographical, cultural or legal boundaries, or transport costs, import tariffs and other trade barriers in the case of exports. Oligopolistic advantages increase the market concentration and can be derived from factors that

create barriers to entry for new competitors, e.g. superior technology, human capital, high initial capital costs or product differentiation (Lall, 1980).[2]

In particular, firms develop new, and improve existing, products and processes by spending resources on R&D.[3] If successful, they may obtain a technologically based competitive edge relative to competitors, in turn leading to a possible increase in foreign market shares.[4] Several empirical studies have supported such a one-way causal relationship, for example Swedenborg (1982) using Swedish data, Lall (1980) and Kravis and Lipsey (1992) analyzing U.S. data, Greenhalgh (1990) studying U.K. industry data, and Hirsch and Bijaoui (1985) who used an Israeli data set. The long term objective for the firm must be to maximize profits. In the short and intermediate term, however, the firm may try to obtain larger market shares in order to have a greater base to exploit profits from in the future.[5]

Turning to the determinants of R&D expenditures, the market structure and the R&D behavior of competitors are relevant explanatory variables, especially in oligopolistic markets (Caves, 1996). Factors that create internal or external funds, e.g. profitability, solidity or cash flow, should also be of importance for R&D investment decisions. When a firm expands sales - and in the case of MNCs from small countries especially sales in foreign markets - the R&D-created knowledge will be utilized more extensively, leading to an increased rate of return on each

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[2] These advantages are not necessarily dependent on factor intensities. A firm's products may be internationally competitive regardless of whether the production process utilizes intensively scarce or abundant productive inputs. The theory of factor intensities (Heckscher-Ohlin) does not need to contradict the theory of barriers to entry. Competitive advantage can be achieved by offering products that contain a high share of relatively abundant inputs, but also by products characterized by superior technology.

[3] An alternative is to buy technology, e.g. through licensing. Trade with licences are of limited magnitude, however, since markets for technology are imperfect. In the case of Swedish MNCs in 1990, total R&D expenditures accounted for almost 25,000 MSEK, while the expenditures of external licenses were only 230 MSEK.

[4] In addition to the generation of new knowledge, R&D has also been found to increase firms' capabilities to assimilate and exploit externally available knowledge (Cohen and Levinthal, 1989).

[5] Profit maximization in the short-run is, in fact, inconsistent with investments in R&D. A firm that maximizes profits with a time horizon of one or two years would probably not undertake any R&D, since the time horizon of such investments are usually much longer.

dollar spent on R&D (Markusen, 1984).[6] More internal funds will also be available to finance further R&D projects if the firm earns profits from its foreign operations (Pugel, 1985; Himmelberg and Petersen, 1994).[7]

This should imply that R&D and foreign sales reinforce each other in a simultaneous manner (Mansfield *et al.*, 1979; Caves, 1996). A large group of theoretical and empirical studies following the Schumpeterian school maintains that there is a positive relationship between R&D activities and firm size, i.e. total sales (for a survey see Cohen and Levin, 1989). These studies argue that large firm size facilitates R&D investment, on similar grounds as discussed above: higher returns on each R&D dollar spent when the firm has a large volume of sales over which to spread fixed R&D costs (Pakes and Schankerman, 1984), or that large firms can more easily raise funds for risky R&D projects. As already noted above, we here choose to relate R&D activities to foreign rather than total sales, since the present study uses data on MNCs from Sweden, a country with a small domestic market. In this case, the growth potential in domestic sales is limited, and hence there is little scope to finance large R&D investments by sales in the home market alone. Foreign markets will thus be essential for the possibilities of expansion as well as financing of R&D activities. If a firm has a large country as its home-base, for instance the United States, the United Kingdom or Japan, the arguments are weaker.

Hughes (1985), using U.K. industry data, took the simultaneity between R&D and exports into account and found that R&D exerted a positive, significant impact on exports. The reverse impact, i.e. how exports affect R&D activities, was never tested. A study on U.S. firms by Hirschey (1981) tested the causal relationship between R&D and foreign sales in both directions in a simultaneous model, but found only a significant impact of foreign sales on R&D expenditures. This model was, however, not based on barriers to entry as determinants of multinational involvement, but instead used market concentration and financial risk as

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[6] For example, Mansfield *et al.* (1979) reports that MNCs based in the United States expect to earn over 30% of the returns on R&D on utilization of the technology in foreign markets. This percentage is likely to be even higher for firms based in a small open economy.

[7] It can be argued that large firms have greater possibilities to raise external funds for R&D. This capacity is, however, rather related to the solidity and profitability of the firm and not to the size *per se*.

explanatory variables.

Sales on foreign markets can be undertaken either through exports from the home country or by production in foreign affiliates. The theory does, however, not predict whether R&D activities determine the choice between exports and foreign production. According to the product cycle theory (Vernon, 1966), the choice between exports and foreign production depends on the historical phase of the product. R&D used for developing new products and processes will, primarily, result in exports from the home country, while R&D used for improving existing products and processes tends to favor foreign production.

3. Data and econometric specification

The data base on Swedish MNCs used in the analysis has been collected by the Industrial Institute for Economic and Social Research (IUI) in Stockholm. It has been updated about every fourth year since 1965 and contains detailed information about individual foreign affiliates as well as statistics about trade and R&D at the firm level. The data set includes practically all Swedish-owned firms in manufacturing with more than 50 employees and with at least one majority-owned producing affiliate abroad.[8] The last two surveys (1986 and 1990) are included in the empirical analysis, since data on market concentration, which is used as an explanatory variable, is not available for earlier years.[9]

When relating R&D to foreign operations, previous studies have used several different measures, e.g. intensities have been compared with absolute levels and foreign operations have often been represented by exports. In the present study, the two main variables are defined as follows:

(1) **RD/TS:** R&D intensity equals the firm's total R&D expenditures, *RD*, divided by total sales of the firm, *TS*. This is the standard measure of technological intensity

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[8] It could be argued that the sample should also contain firms with no production and sales abroad, but data for such firms is not available. Many small firms that have had production abroad for only a few years are, however, included. These small MNCs should represent a group of firms with limited experience of foreign markets.

[9] The sample includes 202 observations, of which 88 are from the 1986 survey and 114 from the 1990 survey. 147 different MNCs are analyzed. 55 of these firms are included twice in the sample and 92 only once.

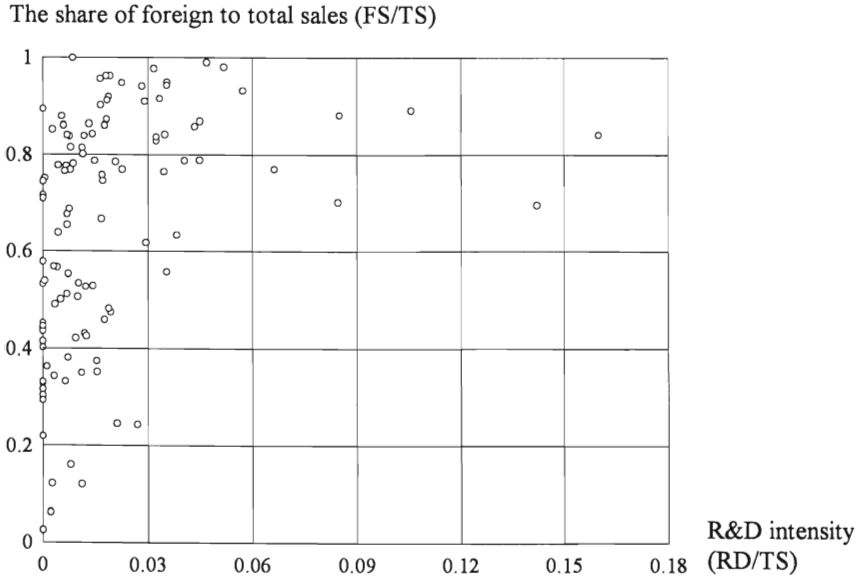
(Scherer, 1980).

(2) **FS/TS:** The share of total sales in foreign markets. Foreign sales, *FS*, is here defined as exports plus foreign production. We argue that *FS* is a better measure of the firm's international activities than either exports or foreign production separately. Like *RD*, *FS* is also divided by *TS*.

The use of intensities controls for historical factors of the firm as well as for firm size and is also a way to reduce heteroscedasticity in the regression analysis. From the plot in Figure 1, there appears to be a positive relationship between *RD/TS* and *FS/TS* for the firms included in the 1990 survey. It is interesting to note that the lower right corner in the figure is empty, i.e. firms which have a low share of foreign to total sales do not have high R&D intensity.

Measuring the strength of the linear relationship, the Pearson correlation

Figure 1. Plot between R&D intensity and the share of foreign to total sales in 1990.



Note: Number of observations equals 114.

coefficient between *RD/TS* and *FS/TS* in 1990 is 0.41 and significant at the 1%-level.[10] This positive relationship also holds when foreign sales are decomposed into exports from Sweden and foreign production. The correlations between *RD/TS* and the share of exports and foreign production to total sales are 0.25 and 0.35, respectively, and are both significant at the 1%-level.

From the plot and correlations above, a positive relationship is expected between firm i's R&D intensity, RD_{it}/TS_{it}, and its degree of internationalization, FS_{it}/TS_{it}, at time t.[11] The model characterizing the relationship between these two variables is specified as follows:[12]

$$\frac{FS_{it}}{TS_{it}} = \beta_0 + \beta_1 \frac{RD_{it}^*}{TS_{it}} + Z_1'\beta + \epsilon_{it} , \qquad (1)$$

$$\frac{RD_{it}^*}{TS_{it}} = \gamma_0 + \gamma_1 \frac{FS_{it}}{TS_{it}} + Z_2'\gamma + \mu_{it} , \qquad (2a)$$

$$\frac{RD_{it}}{TS_{it}} = \begin{cases} \dfrac{RD_{it}^*}{TS_{it}} & \text{if } \dfrac{RD_{it}^*}{TS_{it}} > 0 \\ 0 & \text{if } \dfrac{RD_{it}^*}{TS_{it}} \leq 0 \end{cases} . \qquad (2b)$$

The residuals are assumed to have the desired properties: $\epsilon \sim N(0,\sigma_\epsilon^2)$ and

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[10] The Pearson correlation coefficient is 0.71 between *RD* and *FS*, significant at the 1%-level.

[11] It could be argued that a time lag in the R&D variable should be used, since today's R&D investment will not yield profits or enhance competitiveness until future time periods. Time lags in the regression variables are, however, always a problem in cross-section analysis. If we had used time lags here, the sample would have been reduced considerably. Furthermore, firms' R&D intensities are rather stable in the short or medium term. The Pearson correlation coefficient between R&D intensities in 1986 and 1990, for 55 firms included in both surveys from the corresponding years, was estimated to 0.83, and significant at the 1%-level. This means that today's R&D intensity is a good approximation to the R&D intensity some years ago.

[12] There are two reasons why we did not decompose foreign sales into exports and foreign production in the econometric analysis. First, the theoretical discussion in section 2 indicated that such an analysis would require R&D to be decomposed into separate research and development parts. Second, estimations that included exports (*EXP*) as well as foreign production (*FQ*) were undertaken by the authors, but with three equations instead of two (Equation (1) was estimated twice with *EXP/TS* and *FQ/TS*, respectively, as dependent variables.). The results were not satisfactory, however, since multicollinearity arose in equation (2) in the second stage of 2SLS.

$\mu \sim N(0,\sigma_\mu^2)$; $E(\epsilon_{it}\epsilon_{jt})=0$ and $E(\mu_{it}\mu_{jt})=0$ for $i \neq j$.[13] However, $E(\mu_{it}\epsilon_{it}) \neq 0$, since a simultaneous relationship is expected between *RD/TS* and *FS/TS*.[14]

The method used to estimate the interactions between *RD/TS* and *FS/TS* is a variant of 2SLS with limited endogenous variables, outlined in Nelson and Olson (1978). OLS can be used to estimate the reduced and structural form of equation (1). The other endogenous variable, *RD/TS*, is, however, characterized by some concentration of zeroes (about 18%), i.e. the firms with no R&D expenditures. When estimating equation (2) in the first and second stage of 2SLS, the Tobit method is therefore used.[15] The latent variable, $(RD/TS)^*$, can be interpreted as an index of R&D intensity, of which *FS/TS* will be a function. The *Z*'s are vectors including firm and industry specific attributes, while the β's and γ's denote parameters or vectors of parameters showing the impact of the explanatory variables on the dependent variable. The simultaneous Tobit method yields consistent parameter estimates, but the asymptotic standard errors of the parameter estimates are underestimated. In order to correct for this, the asymptotic variance-covariance-matrix is derived and the standard errors are recalculated according to Amemiya (1979).

The parameters in equation (1) are marginal effects. The estimate of γ_1 in the Tobit equation can not be interpreted as a marginal effect on the actual dependent variable *RD/TS*, however.[16] Rather, it is a combination of the marginal effect on the R&D intensity and the effect on the probability that the firm will have any R&D at all (McDonald and Moffitt, 1980).[17] The parameters β_1 and γ_1 show the

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[13] It should be noted that $E(\mu_{is}\mu_{it}) \neq 0$ and $E(\epsilon_{is}\epsilon_{it}) \neq 0$ for $s \neq t$. A firm which, e.g. has a high R&D intensity in time s, is also expected to have a high R&D intensity in time t. Although not taken account of this in the estimation procedure, the parameter estimates will not be inconsistent. Most firms are only observed once in the sample, which means that this possible autocorrelation should not be a serious problem.

[14] The hypothesis of no simultaneity was tested, and rejected, using a Hausman (1978) test.

[15] There may be a separate process determining whether the firm does R&D from how much R&D the firm does conditional on that a R&D lab exists. In such case, a Heckman (1976) two-step procedure would be used for equation (2). To our knowledge, no simultaneous Heckman procedure is, however, available.

[16] γ_1 is a marginal effect of *FS/TS* on the latent variable $(RD/TS)^*$.

[17] The marginal effect of *FS/TS* on *RD/TS*, $\partial(RD/TS)/\partial(FS/TS)$, simply equals $F(z)\gamma_1$, where $F(z)$ is the cumulative normal distribution and $z=X'\gamma/\sigma_\mu$. *X* is a vector of explanatory variables and γ is the vector of estimated Tobit parameters. The z is calculated around the means of *X*.

direct effect of one intensity on another. The marginal effect of R&D on foreign sales, and vice versa, can be obtained by the following formulas (derived in appendix A):

$$\frac{\partial FS}{\partial RD} = \frac{\beta_1}{1 - A} , \qquad (3)$$

$$where \ A = \beta_0 + Z_1'\beta .$$

$$\frac{\partial^* RD}{\partial^* FS} = C + \gamma_1 , \qquad (4)$$

$$where \ C = \gamma_0 + Z_2'\gamma .$$

The ∂^* in equation (4) indicates the marginal *and* probability effect of *FS* on *RD*.

4. Exogenous variables

In the following, we present the exogenous variables in the model, their definitions and expected impact on the two dependent variables. In accordance with section 2, all explanatory variables included in equation (1), except for the size of the home market, are related to oligopolistic advantages. These factors have been investigated in earlier empirical studies (Lall, 1980; Swedenborg 1979, 1982). The explanatory variables in equation (2), on the other hand, are related to market structure and the possibilities to raise funds for R&D. Table 1 below summarizes the explanatory variables included in each equation. The signs (+ or -) show the expected impacts on the dependent variable.

HIC; According to the theory of oligopolistic advantages (section 2), high initial capital costs on plant level, *HIC*, 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 *FS/TS*. *HIC* is the average plant size, measured as the average book value of real estate, equipment and tools, of the MNC's foreign affiliates.[18] It is, however, not expected

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

that there is any relationship between *HIC* and *RD/TS*.[19]

LS; Firms endowed with skilled labor are assumed to have an advantage relative to other firms. *LS* is measured as the average wage in the home country part of the MNC, and is expected to have a positive influence on *FS/TS*.[20] Even if the wage level to some extent is a choice variable for the firm, we treat *LS* as exogenous in the model.[21]

HOME; Empirical observations about Swedish MNCs indicate that they are more international than MNCs originating from large countries. The size of the home country market, *HOME*, is included in equation (1), suggesting that a small home market forces firms to locate a large share of their sales in foreign markets. Hence, a negative effect is expected on *FS/TS*. *HOME* is measured as total industry sales in MSEK on the Swedish market for the product groups of the MNC (Statistics Sweden, 1986 and 1990).

CONC; Firms operating in oligopolistic industries are more inclined to compete using strategies other than price, including advertising, product differentiation and, above all, R&D activities. The market concentration, *CONC*, is measured as the sum of the world market shares of the four largest firms in the industry where the MNC's largest division operates. A positive effect of *CONC* on R&D intensity is expected. *CONC* is not included in equation (1), however, since it is regarded more as an outcome of various oligopolistic advantages rather than as a cause of such advantages.[22]

PROFIT; A higher profit implies a greater ability to raise internal funds to finance R&D projects. The profit variable, *PROFIT*, is defined as operating income

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[19] There is no empirical evidence for any relationship between *HIC* and *RD/TS*, which are both oligopolistic advantages. For example, firms operating in a basic industry often have high initial capital requirements to their large plants, but very low R&D intensity. On the other hand, firms in chemicals have high R&D intensity and small plants.

[20] Here we use the Swedish average wage, since the average wage for the whole MNC will be largely influenced by the income level in the respective host country where the MNC operates.

[21] The wage setting on the Swedish labor market is largely determined by industry level bargaining. The wage dispersion across firms in a certain job-category should therefore be limited. Thus, *LS*, rather reflects the composition of the labor force, which is partly industry specific.

[22] Although the market concentration may be endogenously determined in the long run, it is here regarded as predetermined. The reason is that the world market concentration for a given industry is rather stable over longer periods, and is only to a limited degree affected by the actions of an individual firm.

Table 1. Explanatory variables included in each equation and the expected impact on the dependent variable.

Dependent variable		*FS/TS*	*RD/TS*
Explanatory variables	Description	Equation (1)	Equation (2)
RD/TS	Total R&D / Total sales	+	
FS/TS	Foreign sales / Total sales		+
HIC	High initial costs	+	
LS	Labor skill	+	
HOME	Size of home market	-	
CONC	Concentration		+
PROFIT	Profit margin		+

Note: Means and standard deviations for the variables are available in Table 10, appendix C.

before depreciation divided by total sales, i.e. gross profit margin. We expect this variable to exert a positive impact on firms' R&D intensity. Again, it can be discussed whether *PROFIT* is exogenous in the model. We argue that this is reasonable, considering that a firm's profit level for a certain year will to a large extant be influenced by business cycles and stochastic chocks. The reason to include *PROFIT* is mainly for the fund raising capacity in one point in time, and e.g. not the MNC's long term profitability or survival.

It should be noted that the size of the firm by itself does not confer a distinct firm-specific advantage, but is rather a consequence of different oligopolistic advantages, e.g. scale economies, technological and human skills. Some previous studies have claimed that there is a positive relationship between the size of the firm and its R&D intensity (Cohen and Levin, 1989). However, in analyzing the simultaneous relationship between R&D and foreign sales, Hirschey (1982) included firm size (measured as total sales) in the R&D equation, but found no significant effect. Also Cohen *et al.* (1987) concluded that overall firm size is not significantly related to R&D intensity. We have not included firm size in our basic model, but a variant of the model will be estimated where firm size measured as total

employees, *EMP*, is included.[23]

We use additive dummy variables to control for fixed industry and time effects which may affect the level of *FS/TS* and *RD/TS*.[24] By including interaction dummies, we also examine if the parameters to the endogenous variables, β_1 and γ_1, are different for industries undertaking R&D aimed for product and process innovations, respectively. R&D undertaken in the engineering and pharmaceutical industries is assumed to primarily aim for product innovations. In the iron & steel, paper & pulp and 'other' industries, including textile, food, cement and wood industries, R&D is assumed to be basically aimed at process innovations. The large R&D spenders can be found in the product-R&D group.

Finally, with regards to exogenous variables, a few comments on the interaction of competing firms' R&D levels are provided. The R&D activities of one firm may increase or decrease the R&D undertaken by its competitors, and vice versa. This depends on whether the firms' R&D are substitutes or complements, whether R&D spillovers between the firms are present, and the market structure of the industry in question. It is true that most of the MNCs in the Swedish sample have their competitors abroad, but in a few cases we can identify Swedish MNCs that are close competitors. An important observation in the data material is that rivals tend to have similar R&D intensities.[25] By means of the industry dummies discussed above, we indirectly try to control for R&D interactions between firms. Furthermore, the inter-firm R&D behavior is also taken into account by including the market structure variable, *CONC*. Close rivals should have similar market concentration, partly explaining the correspondence in R&D intensities.

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[23] Ideally we should measure firm size as total sales, *TS*, but this variable would partly be endogenous since it includes foreign sales, *FS*.

[24] This is done by assigning an additive time dummy for 1986 and additive dummies for different industries: food, textile, basic chemicals, pharmaceuticals & advanced chemicals, paper & pulp, iron & steel, metal products, machinery, electronics, transport equipment and a last group of other industries. Since an individual firm is never included more than twice in the sample, there is no room for the use of firm-specific effects.

[25] There are around 10 cases in the data set where two or more firms are close rivals to each other, e.g. pharmaceuticals, transport equipment, paper, pulp and wood products, machinery, textile and cement industries. In almost all cases, the competing firms have their R&D intensities on approximately the same level. Due to confidentiality, however, we can not report figures on individual firms.

5. Empirical results

The results of the simultaneous estimation are provided in Tables 2 and 3 below. Heteroscedasticity, outliers or non-linearity were no serious problems in the estimations, as can be seen in appendix B. In Table 2, the estimated parameters of *RD/TS* and *FS/TS* in equations (1) and (2), respectively, are both positive, and significant at the 1%-level. By calculating the marginal effects according to equations (3) and (4), the direct effect of an increase in *RD* on *FS*, and vice versa,

Table 2. Results of simultaneous estimations.

Method = Simultaneous Tobit	Dependent variable	
	FS/TS	*RD/TS*
Explanatory variables	Equation (1)	Equation (2)
$\widehat{RD/TS}$	5.18 *** (1.31)	---
$\widehat{FS/TS}$	---	0.083 *** (0.033)
HIC	6.54 E-4 ** (3.08 E-4)	---
LS	-0.394 (0.485)	---
HOME	-4.46 E-6 (4.05 E-6)	---
CONC	---	2.29 E-4 * (1.39 E-4)
PROFIT	---	0.078 ** (0.034)
Adjusted R^2	0.35	---
F-value	8.37	---
Log-likelihood ratio	---	118.8
Number of observations	202	202
Left-censored obs.	---	34

Note: ***, ** and * indicate significance at 1, 5 and 10 percent level respectively. Standard errors in parentheses. Intercepts, dummies for time and industries are shown in Table 4, appendix B. First-stage estimates are shown in Table 5, appendix C.

is obtained. The first row in Table 3 indicates that both $\partial FS/\partial RD$ and $\partial^* RD/\partial^* FS$ are significant at the 1%-level. This suggests that R&D expenditures create competitive advantages on foreign markets and that sales abroad facilitate R&D activities. Thus, R&D expenditures and foreign sales seem to reinforce each other in accordance with our main hypothesis set up earlier.

Considering the estimated derivatives for the two groups "product-R&D" and "process-R&D" industries in Table 3, we notice that $\partial FS/\partial RD$ is significant at the 1%-level in the former and at the 5%-level in the latter group. It can also be shown that the difference in the parameter estimate across the two groups is not significant (see Table 6, appendix C). The difference is, however, significant for $\partial^* RD/\partial^* FS$. The estimated derivative for the product-R&D group is significant at the 1%-level, while it is insignificant for the process-R&D industry, meaning that we can not tell if a change in *FS* affects *RD* in the process-R&D group at all.

Turning to the exogenous variables included in the model, the variable measuring high initial capital costs, *HIC*, has the expected positive impact on *FS/TS* and the parameter is significant at the 5%-level. This gives some support to the view that high initial costs limit entry by new firms and give an advantage to firms

Table 3. Estimated derivatives for the main variables, total and across industries.

Estimated derivatives	$\partial FS/\partial RD$	$\partial^* RD/\partial^* FS$
Industries	Equation (3)	Equation (4)
All industries (n=202)	11.14 *** (1.87)	0.048 *** (0.013)
"Product-R&D" group (n=104)	6.03 *** (1.79)	0.044 *** (9.26 E-3)
"Process-R&D" group (n=98)	10.35 ** (5.01)	2.73 E-3 (0.0226)
Significant difference between industries?	No	Yes

Note: ***, ** and * indicate significance at 1, 5 and 10 percent, respectively. Standard errors in parentheses. The estimated derivative equals the marginal effect in equation (3), but the marginal *and* probability effect in equation (4). The original regressions with industry estimates are available in Tables 6 and 7, appendix C.

already established in the market. The parameter of *LS*, labor skill in the MNC, has a surprisingly negative sign, but is not significant.[26] The size of the home market of the firm's products, *HOME*, seems to have no major impact on sales on foreign markets. The parameter is negative but not significant. The concentration ratio, *CONC*, exerts a positive impact on *RD/TS*, and the estimated parameter is significant at the 10%-level. Thus, there are weak evidence that an oligopolistic market structure favors competition by strategies other than pricing. The parameter of the profit variable, *PROFIT*, is positive and significant at the 5%-level. As discussed in section 4, we also estimated a variant of the model with firm size, *EMP*, as an exogenous variable in the R&D equation. *EMP* did not turn out significant and did not alter the results for the other variables, as can be seen in Table 8 in appendix C.

6. Concluding remarks

The simultaneous relationship between R&D and foreign sales was empirically analyzed, using detailed firm-level data on Swedish multinationals in manufacturing. Positive and statistically significant effects were found in both directions. The only previous study explicitly addressing the issue used data for U.S. firms in manufacturing, but did not find evidence of the expected two-way relationship. This may imply that the interaction between R&D and the penetration of foreign markets especially applies to MNCs from small open economies, and that the relationship is weaker for MNCs originating from countries with large home markets, such as the U.S., the U.K. or Japan.

When analyzing product- and process-related R&D separately, proxied by the MNCs' industry classification, the two-way relationship is only confirmed for the product-related type. Although R&D influences foreign sales in both types, the reinforcing effect between the two variables is not found for process-related R&D. This may, in part, be explained by the fact that the large R&D investors deal with product innovations and it is these firms which are dependent on foreign markets

[26] A possible explanation to the poor performance of *LS* may be that the average wage level is not an appropriate indicator of labor skill. No alternative measure is, however, available in the data set.

for financing of R&D. Another explanation is that product innovations are essentially associated with entry into new product markets, while process R&D aims at reducing costs in producing a given range of products. Moreover, Mansfield (1984) suggests that firms are more hesitant to utilize their process technologies abroad as compared with their product technologies. He argues that once process technologies go abroad, it is difficult to determine whether foreign firms are illegally imitating processes relative to products. However, deeper research on the difference between process and product technologies is necessary in order to draw any further conclusions.

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Appendix A

The marginal effect of an increase in *RD* on *FS* can be derived by first dividing total sales, *TS*, in equation (1) into foreign, *FS*, and domestic sales, *DS*:

$$\frac{FS}{FS + DS} = A + \beta_1 \frac{RD}{FS + DS}, \qquad \textbf{(5)}$$

$$\textit{where } A = \beta_0 + Z_1'\beta,$$

$$TS = FS + DS.$$

After that one solves for *FS*:

$$FS = \frac{1}{1 - A}(A\,DS + \beta_1 RD). \qquad \textbf{(6)}$$

This gives the partial derivative:

$$\frac{\partial FS}{\partial RD} = \frac{\beta_1}{1 - A}. \qquad \textbf{(7)}$$

In a similar way, the effect of *FS* on *RD* can be derived:

$$\frac{\partial^* RD}{\partial^* FS} = C + \gamma_1, \qquad \textbf{(8)}$$

$$\textit{where } C = \gamma_0 + Z_2'\gamma.$$

In this case, ∂^* indicates the total partial effect (marginal and probability effect). *A* and *C* are calculated around the means of Z_1 and Z_2.

The standard error of $\partial FS/\partial RD$ is calculated, using a first-order linear approximation, according to Blom (1980):

$$\sigma_{\partial FS\,/\,\partial RD} = \sqrt{Var\left(\frac{\beta_1}{1 - A}\right)} = \sqrt{Var\,(g\,(\beta_0, \beta_1, \ldots, \beta_k))} \qquad \textbf{(9)}$$

$$= \sqrt{\sum_{i=0}^{k} Var(\beta_i)\left(\frac{\partial g}{\partial \beta_i}\right)^2 + 2\sum_{i=0,\, i<j}^{k} Cov(\beta_i, \beta_j)\left(\frac{\partial g}{\partial \beta_i}\right)\left(\frac{\partial g}{\partial \beta_j}\right)} \ ,$$

where

$$\frac{\partial g}{\partial \beta_1} = \frac{1}{1 - A} \ ,$$

$$\left.\frac{\partial g}{\partial \beta_i}\right|_{i \neq 1} = \frac{\beta_1}{(1 - A)^2} X_i \ .$$

The standard error of $\partial^* RD / \partial^* FS$ is calculated in a similar manner:

$$\sigma_{\partial^* RD \,/\, \partial^* FS} = \sqrt{\sum_{i=0}^{k} Var(\gamma_i)\left(\frac{\partial h}{\partial \gamma_i}\right)^2 + 2\sum_{i=0,\, i<j}^{k} Cov(\gamma_i, \gamma_j)\left(\frac{\partial h}{\partial \gamma_i}\right)\left(\frac{\partial h}{\partial \gamma_j}\right)} \ , \qquad \textbf{(10)}$$

where

$$h = h(\gamma_0, \gamma_1, \ldots, \gamma_k) \ ,$$

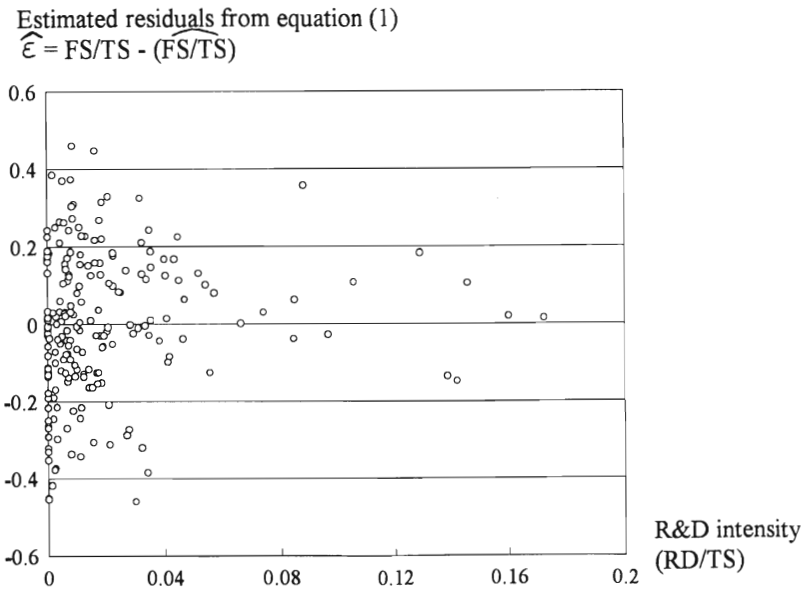
$$\frac{\partial h}{\partial \gamma_1} = 1 \ ,$$

$$\left.\frac{\partial h}{\partial \gamma_i}\right|_{i \neq 1} = X_i \ .$$

Appendix B

The plot between *RD/TS* and *FS/TS* in Figure 1 suggests the possibility of heteroscedastic residuals in equations (1) and (2), since the bivariate relationship between *FS/TS* and *RD/TS* appears to be non-linear. In Figure 2, there is a plot between the estimated residuals, ϵ, from equation (1) and the explanatory variable *RD/TS*. No non-linearity can be detected between the estimated residuals and *RD/TS* in this plot. A Park-Glejser test for heteroscedasticity also verified that the variance of the estimated residuals were unrelated to *RD/TS*.[27]

Figure 2. Plot between R&D intensity and the estimated residuals from equation (1).



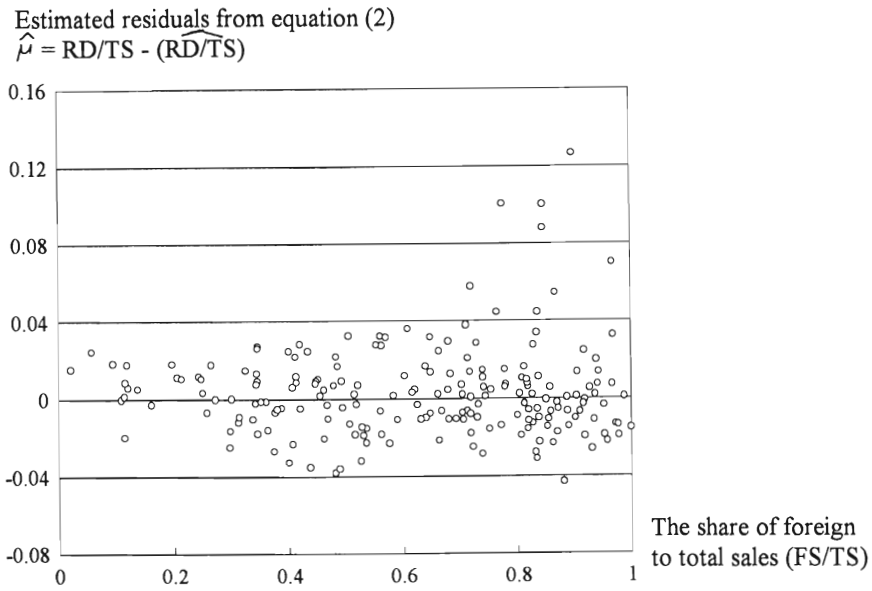
[27] The Park-Glejser test was performed by running the OLS-regression:

$\log(\epsilon^2_{it}) = \alpha_0 + \alpha_1 \log(RD/TS)_{it} + \eta_{it}$.

If the slope parameter α_1 is insignificantly different from zero, we assume that the residuals are homoscedastic.

In Figure 3, the estimated residuals from equation (2), μ, are plotted against *FS/TS*. Here, there are at the first sight some tendencies to heteroscedasticity, but again the Park-Glejser test could not reject the hypothesis that the variance of the estimated residuals was homoscedastic with respect to *FS/TS*. A few residuals lie in the upper right corner, but a large group of residuals associated with a high value of *FS/TS* are situated around the mean of zero. This suggests that non-linearities is not a serious problem in the estimations.

Figure 3. Plot between the share of foreign to total sales and the estimated residuals from equation (2).



Appendix C

Table 4. Supplement to Table 2. Second-stage estimates of dummies for time and industries.

Method = Simultaneous Tobit	Dependent variable	
	FS/TS	*RD/TS*
Explanatory variables	Equation (1)	Equation (2)
Intercept	0.650*** (0.090)	-0.060*** (0.016)
Time dummy 1986	0.026 (0.037)	6.25 E-4 (4.51 E-3)
Dummy food industry	-0.281*** (0.077)	0.024* (0.014)
Dummy textiles	-0.048 (0.082)	6.44 E-3 (0.011)
Dummy basic chemicals	-0.035 (0.071)	5.10 E-3 (9.10 E-3)
Dummy pharmaceuticals & advanced chemicals	-0.178** (0.073)	0.032*** (7.85 E-3)
Dummy machinery	0.094* (0.055)	-3.42 E-3 (8.01 E-3)
Dummy electronics	-0.114* (0.073)	0.020** (8.99 E-3)
Dummy transport equipment	-0.140 (0.122)	0.038*** (0.012)
Dummy paper & pulp	-9.51 E-3 (0.070)	-1.59 E-4 (8.12 E-3)
Dummy iron & steel	-0.052 (0.108)	6.84 E-3 (0.013)
Dummy other industries	-0.128** (0.060)	0.014 (9.31 E-3)

Note: ***, ** and * indicate significance at 1, 5 and 10 percent level respectively. Standard errors in parentheses. The metal products industry is the reference group for the industry dummies.

Table 5. Supplement to Table 2. First-stage estimates.

Method = Simultaneous Tobit	Dependent variable	
	FS/TS	*RD/TS*
Explanatory variables	Equation (1)	Equation (2)
Intercept	0.448***	-0.040***
	(0.072)	(0.010)
HIC	1.06 E-3 ***	7.10 E-5 **
	(2.43 E-4)	(3.20 E-5)
LS	0.294	0.124**
	(0.371)	(0.050)
HOME	-2.64 E-6	1.84 E-7
	(3.60 E-6)	(4.79 E-7)
CONC	2.96 E-3 ***	4.70 E-4 ***
	(6.09 E-4)	(8.11 E-5)
PROFIT	0.021	0.071**
	(0.213)	(0.031)
Time dummy 1986	0.071**	7.71 E-3 *
	(0.030)	(4.08 E-3)
Dummy food industry	-0.305***	-2.43 E-3
	(0.067)	(9.01 E-3)
Dummy textiles	-0.052	1.97 E-3
	(0.071)	(9.99 E-3)
Dummy basic chemicals	-0.039	1.31 E-4
	(0.062)	(8.21 E-3)
Dummy pharmaceuticals & advanced chemicals	-0.017	0.029***
	(0.053)	(7.09 E-3)
Dummy machinery	0.102**	4.43 E-3
	(0.048)	(6.39 E-3)
Dummy electronics	-0.030	0.019**
	(0.060)	(8.09 E-3)
Dummy transport equipment	0.042	0.034***
	(0.093)	(0.013)
Dummy paper & pulp	-0.044	-6.25 E-3
	(0.058)	(8.17 E-3)
Dummy iron & steel	-0.086	-7.62 E-3
	(0.094)	(0.013)
Dummy other industries	-0.074	9.28 E-3
	(0.052	(6.96 E-3)
Adjusted R^2	0.36	---
F-value	8.12	---
Log-likelihood ratio	---	126.72
Number of observations	202	202
Left-censored obs.	---	34

Note: ***, ** and * indicate significance at 1, 5 and 10 percent level respectively. Standard errors in parentheses. The metal products industry is the reference group for the industry dummies.

Table 6. Results of simultaneous estimations for industries dealing with product and process R&D. Second-stage estimates.

Method = Simultaneous Tobit	Dependent variable			
	FS/TS		*RD/TS*	
Explanatory variables	Equation (1)		Equation (2)	
	Parameter	Std. error	Parameter	Std.error
$\widehat{RD/TS}$	2.56***	0.940	---	---
$(\widehat{RD/TS})\times$Dummy Process	2.23	2.95	---	---
$\widehat{FS/TS}$	---	---	0.071***	0.025
$(\widehat{FS/TS})\times$Dummy Process	---	---	-0.116***	0.017
HIC	9.40 E-4 ***	3.05 E-4	---	---
LS	0.291	0.477	---	---
HOME	-5.36 E-6	4.47 E-6	---	---
CONC	---	---	2.53 E-4 **	1.11 E-4
PROFIT	---	---	0.051*	0.029
Intercept	0.540***	0.090	-0.050***	0.013
Time dummy 1986	0.056	0.037	3.04 E-3	3.79 E-3
Dummy food industry	-0.302***	0.080	0.056***	0.012
Dummy textiles	-0.056	0.083	0.063***	0.013
Dummy basic chemicals	-0.017	0.084	0.076***	0.014
Dummy pharm. & adv. chemicals	-0.148*	0.084	0.082***	9.45 E-3
Dummy machinery	0.122**	0.056	-2.82 E-3	6.60 E-3
Dummy electronics	-0.067	0.073	0.019**	7.57 E-3
Dummy transport equipment	-0.025	0.121	0.037***	9.80 E-3
Dummy paper & pulp	-0.063	0.071	0.072***	0.013
Dummy iron & steel	-0.072	0.126	0.066***	0.014
Dummy other industries	-0.130	0.072	0.074***	0.011
Adjusted R^2	0.32		---	
F-value	6.84		---	
Log-likelihood ratio	---		152.40	
Number of observations	202		202	
Left-censored obs.	---		34	

Note: ***, ** and * indicate significance at 1, 5 and 10 percent level respectively. First-stage estimates are shown in Table 7. The metal products industry is the reference group for the industry dummies.

Table 7. Results of simultaneous estimations for industries dealing with product and process R&D. First-stage estimates.

Method = Simultaneous Tobit	Dependent variable			
	FS/TS		*RD/TS*	
Explanatory variables	Equation (1)		Equation (2)	
	Parameter	Std. error	Parameter	Std.error
HIC	1.29 E-3 ***	4.26 E-4	1.67 E-5	4.50 E-5
HIC×Dummy Process	-3.38 E-4	5.21 E-4	1.53 E-5	5.51 E-5
LS	0.059	0.469	0.236 ***	0.050
LS×Dummy Process	0.214	0.535	-0.297 ***	0.058
HOME	-5.92 E-6	5.37 E-6	2.01 E-6 ***	5.62 E-7
HOME×Dummy Process	3.87 E-6	7.11 E-6	-2.58 E-6 ***	7.55 E-7
CONC	3.84 E-3 ***	8.55 E-4	3.10 E-4 ***	9.21 E-5
CONC×Dummy Process	-1.89 E-3	1.23 E-3	-6.43 E-5	1.31 E-4
PROFIT	4.27 E-3	0.268	0.076 **	0.034
PROFIT×Dummy Process	-0.048	0.437	-0.060	0.050
Intercept	0.474 ***	0.080	-0.060 ***	8.81 E-3
Time dummy 1986	0.070 **	0.031	4.81 E-3	3.29 E-3
Dummy food industry	-0.298 ***	0.102	0.067 ***	0.011
Dummy textiles	-0.059	0.103	0.065 ***	0.011
Dummy basic chemicals	0.020	0.104	0.073 ***	0.011
Dummy pharm. & adv. chemicals	-0.045	0.079	0.082 ***	8.37 E-3
Dummy machinery	0.077	0.051	0.010 *	5.43 E-3
Dummy electronics	-0.041	0.061	0.022 **	6.58 E-3
Dummy transport equipment	0.035	0.114	9.59 E-3	0.012
Dummy paper & pulp	-0.043	0.101	0.071 ***	0.011
Dummy iron & steel	-0.076	0.142	0.081 ***	0.015
Dummy other industries	-0.067	0.090	0.075 ***	9.56 E-3
Adjusted R^2	0.36		---	
F-value	6.34		---	
Log-likelihood ratio	---		152.40	
Number of observations	202		202	
Left-censored obs.	---		34	

Note: ***, ** and * indicate significance at 1, 5 and 10 percent level respectively. The metal products industry is the reference group for the industry dummies.

Table 8. Results of the simultaneous estimations when total firm size is included in equation (2). Second-stage estimates.

Method = Simultaneous Tobit	Dependent variable			
	FS/TS		*RD/TS*	
Explanatory variables	Equation (1)		Equation (2)	
	Parameter	Std.error	Parameter	Std.error
$\widehat{RD/TS}$	5.31 ***	1.291	---	---
$\widehat{FS/TS}$	---	---	0.084 *	0.044
HIC	6.39 E-4 **	3.10 E-4	---	---
LS	-0.417	0.485	---	---
HOME	-4.39 E-6	4.07 E-6	---	---
CONC	---	---	2.26 E-4	1.63 E-4
PROFIT	---	---	0.079 **	0.035
EMP	---	---	-2.20 E-8	1.76 E-7
Intercept	0.653 ***	0.089	-0.060 ***	0.225
Time dummy 1986	0.025	0.037	5.80 E-4	4.66 E-3
Dummy food industry	-0.281 ***	0.077	0.024	0.016
Dummy textiles	-0.047	0.081	6.53 E-3	0.011
Dummy basic chemicals	-0.036	0.072	5.07 E-3	9.06 E-3
Dummy pharm. & adv. chemicals	-0.182 **	0.073	0.032 ***	7.85 E-3
Dummy machinery	0.093 *	0.055	-3.49 E-3	8.43 E-3
Dummy electronics	-0.116	0.072	0.020 *	0.011
Dummy transport equipment	-0.146	0.123	0.039 ***	0.013
Dummy paper & pulp	-7.92 E-3	0.069	7.69 E-5	8.15 E-3
Dummy iron & steel	-0.053	0.108	6.94 E-3	0.013
Dummy other industries	-0.129 **	0.061	0.014 *	8.48 E-3
Adjusted R^2	0.36		---	
F-value	6.52		---	
Log-likelihood ratio	---		146.46	
Number of observations	202		202	
Left-censored obs.	---		34	
Estimated derivatives	Parameter	Std.error	Parameter	Std.error
$\partial FS/\partial RD$	11.36 ***	1.89	---	---
$\partial^* RD/\partial^* FS$	---	---	0.049 ***	0.017

Note: ***, ** and * indicate significance at 1, 5 and 10 percent level respectively. First-stage estimates are shown in Table 9. The metal products industry is the reference group for the industry dummies.

Table 9. Results of the simultaneous estimations when total firm size is included in equation (2). First-stage estimates.

Method = Simultaneous Tobit	Dependent variable			
	FS/TS		*RD/TS*	
Explanatory variables	Equation (1)		Equation (2)	
	Parameter	Std. error	Parameter	Std.error
HIC	8.71 E-4 ***	2.66 E-4	5.95 E-5 *	3.48 E-5
LS	0.282	0.370	0.123 ***	0.050
HOME	-3.42 E-6	3.62 E-6	1.34 E-7	4.83 E-7
CONC	2.89 E-3 ***	6.08 E-4	4.66 E-4 ***	8.09 E-5
PROFIT	0.018	0.212	0.071 **	0.031
EMP	1.58 E-6	9.64 E-7	9.67 E-8	1.26 E-7
Intercept	0.458 ***	0.072	-0.039 ***	9.99 E-3
Time dummy 1986	0.068 **	0.030	7.54 E-3 *	4.08 E-3
Dummy food industry	-0.300 ***	0.067	-2.09 E-3	9.00 E-3
Dummy textiles	-0.051	0.070	2.02 E-3	9.98 E-3
Dummy basic chemicals	-0.033	0.062	5.33 E-4	8.22 E-3
Dummy pharm. & adv. chemicals	-0.014	0.053	0.030 ***	7.09 E-3
Dummy machinery	0.096 **	0.048	4.08 E-3	6.40 E-3
Dummy electronics	-0.072	0.065	0.016 *	8.86 E-3
Dummy transport equipment	-0.021	0.098	0.032 **	0.013
Dummy paper & pulp	-0.038	0.058	-5.83 E-3	8.16 E-3
Dummy iron & steel	-0.075	0.094	-6.96 E-3	0.013
Dummy other industries	-0.074	0.052	9.27 E-3	6.95 E-3
Adjusted R^2	0.37		---	
F-value	7.88		---	
Log-likelihood ratio	---		152.40	
Number of observations	202		202	
Left-censored obs.	---		34	

Note: ***, ** and * indicate significance at 1, 5 and 10 percent level respectively. The metal products industry is the reference group for the industry dummies.

Table 10. Means and standard deviations for the variables included in the model.

Variable	Description and definition	Mean	Std. deviation
RD/TS	Total R&D expenditures as a percentage of total sales.	0.020	0.029
FS/TS	Foreign sales as a percentage of total sales.	0.621	0.244
HIC	High initial costs. Average book value of real estate, equipment and tools at plant level (MSEK).	35.53	65.92
LS	Average wage level in the parent company (MSEK).	0.170	0.041
HOME	Size of the home market for the firm's products (MSEK).	6760	6313
CONC	Concentration. C4 in the industry in which the firm's largest division operates.	32.19	26.52
PROFIT	Profit margin. Operating income before depreciation as a percentage of total sales.	0.103	0.072

Chapter VI

The IUI Survey Data on Swedish Multinational Corporations

Data on Swedish MNCs has been collected by the Industrial Institute for Economic and Social Research (IUI) about every fourth year since the mid-1960s. The years covered are 1965, 1970, 1974, 1978, 1986 and 1990. The IUI data base is not only unique within Sweden. No other information set covers MNCs from a single country equally well in terms of scope or detail. Nowhere else is comprehensive time-series data available on the operations and transactions of individual affiliates. The data provides detailed information on nearly three decades of internationalization, making it possible to consider changes in the organizational structure as well as to trace changes over time in individual MNCs or affiliates around the world.

For the 1990 questionnaire, Thomas Andersson has been responsible for the design and execution of the data base. Previous surveys were undertaken by Birgitta Swedenborg. The 1990 question set was updated by Gunnar Fors who, together with Nicklas Andersson and Torbjörn Fredriksson, also participated in the collection of the 1990 data. Roger Svensson has been responsible for organizing the data and for statistical computations.

Purpose and scope of the surveys

The purpose of the surveys has been to obtain information about and analyze the foreign operations of Swedish industry. Data has been collected at five occasions: 1971, 1975, 1979, 1987 and 1991.[1] The survey covers all Swedish MNCs in

[1] A similar investigation covering the years 1960-65 was carried out by Lund (1967). A mapping of employment in the foreign affiliates of Swedish MNCs was undertaken by Statistics Sweden in 1974 and coordinated with IUI for that year. For the late 1980s, close comparisons have been possible with the data of NUTEK (Swedish National Board for Industrial and Technical Development) and the Federation of Swedish Industries for the 20 largest Swedish firms in manufacturing.

manufacturing with more than 50 employees, and with majority-owned producing and/or sales affiliates abroad.[2] Only companies which are registered in Sweden, belong to the manufacturing sector (ISIC 3), and are owned to more than 50 percent in Sweden, have been included. Thus, the data does not cover Swedish-based affiliates of foreign MNCs and firms whose major line of operations falls outside manufacturing.[3] Manufacturing firms that are owned by Swedish holding companies have been treated as separate MNCs and as independent of the non-manufacturing part of the corporate group. In principle, all Swedish parts, i.e., including Swedish-owned subsidiaries in Sweden, are regarded as the parent company. The questions concern the MNC as a whole (Form A) as well as individual foreign manufacturing affiliates (Form B).

Foreign affiliates are defined as companies which are directly or indirectly owned by the parent company to more than 50 percent and are included in the consolidated accounts of the MNC. A Form B has been filled in for all affiliates performing some kind of manufacturing operations, even if this is not its main activity in value terms. For those which are not engaged in manufacturing but perform, e.g., sales functions, treasury, insurance or transport activities, information is available on the geographical distribution of the number of employees.

To allow for comparisons over time, the general structure of the IUI question form has remained relatively unchanged over the years. Nevertheless, some modifications should be noted for 1990. First, several questions, which previously made a distinction between operations in Sweden and abroad, distinguish between operations in the EC and the rest of the world in the 1990 questionnaire. Second, several new questions have been added covering acquisitions undertaken in 1990, training and marketing expenditures, as well as market structures (see Form A).

Data collection and rate of response

The population of Swedish MNCs was identified by combining two extracts from the

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[2] In certain years, the questionnaire has also included foreign minority-owned affiliates (1965, 1970, 1974 and 1978).

[3] Due to these limitations, Asea Brown Boveri is not regarded as a Swedish-owned company in the 1990 survey.

corporate register at Statistics Sweden, covering all large company groups on the one hand and all manufacturing firms with at least 50 employees and with majority-owned affiliates abroad on the other. This information was complemented with companies that were included by Swedenborg et al. (1988) in the previous survey but had not shown up in the information from Statistics Sweden. The questionnaire was then distributed to about 500 companies that seemingly matched the criteria for inclusion. Additional information obtained through direct contacts with the identified companies, however, led to the exclusion of many entities and narrowed the population to 350 units.

Throughout, the response rate of the IUI surveys has exceeded 90 percent in terms of number of companies. Concerning the 1990 survey, 329 out of the total of 350 companies (or 94 percent) replied. Among the respondents, there were 210 without and 119 with manufacturing affiliates abroad. The response rate was 95 percent for the former and 92 percent for the latter. In terms of the total value of investment, the coverage is even more extensive, since mainly smaller MNCs declined to reply to the questionnaire. The required information has sometimes been unavailable or very difficult to produce, which has resulted in a lower response rate for certain questions. Still, it practically always remains above 80 percent. The 119 MNCs with production abroad have completed Form A and a Form B for each manufacturing affiliate. The 1990 survey encompasses information concerning 713 foreign manufacturing affiliates.[4]

It should be noted that the gathering of information has become more burdensome for firms over time as Swedish MNCs have grown considerably. For instance, in 1970, the 20 largest MNCs had 11 producing affiliates on average compared to 25 in 1990. In addition, the organization of business activities has also become more decentralized in terms of financial reporting and information is not always readily available in headquarters. Thus, the collection of information has been possible only thanks to tremendous efforts made by the participating respondents. Due to a large number of mergers and acquistions, it has also become increasingly difficult to monitor MNCs over time.

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[4] MNCs with foreign sales affiliates exclusively have only completed the first part of form A (questions 1-13).

ACTIVITIESOF SWEDISH MULTINATIONALCOMPANIES ABROAD 1990

INSTRUCTIONS FOR THE QUESTIONNAIRE

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The questionnaires should be returned before 29 November 1991 to The Industrial Institute for Economic and Social Research.

I. Which companies are to answer the questionnaire?

The investigation comprises all Swedish manufacturing enterprises that had foreign affiliates in 1990.

II. The purpose of the investigation

This questionnaire is a follow-up of earlier surveys conducted by the Institute in 1965, 1970, 1974, 1978 and 1986. The purpose is to investigate the extent and direction of Swedish enterprises' foreign operations. The 1990 questionnaire is basically designed in the same way as earlier years in order to facilitate comparisons over time.

III. Definitions

A Swedish enterprise is defined as a company registered in Sweden and not being an affiliate of a foreign enterprise. In addition, its main activity shall be within manufacturing.

Affiliates are defined as companies in which the parent company holds directly, or jointly with other subsidiaries, more than 50% of the shares. Those affiliates are treated as subsidiaries in the consolidated statements according to the Swedish Companies Act.

Production affiliates are defined as companies engaged in extraction, manufacturing or assembly of goods. Production affiliates include also those in which production of goods is only a minor part of their overall activity.

Sales affiliates are those which exclusively are dealing with sales, possibly combined with installation and service activities. Sales activities should predominantly involve goods produced by companies belonging to the same group.

Other operating affiliates are defined as companies that are neither producing nor selling according to the definitions above (e.g. finance, service, etc).

The Swedish company group or **the Swedish part of the group** consists of the parent company and subsidiaries located in Sweden.

Foreign affiliates or **the foreign part of the group** consists of companies located abroad.

Subsidiaries located in the European Community (EC) constitute **the EC part of the group.** The EC consists of the following countries:

Belgium	Germany	Greece
France	Great Britain	Denmark
Italy	Spain	Irland
The Netherlands	Portugal	Luxembourg

IV. The disposition of the questionnaire

The questionnaire is sent to the parent company of the group. The parent company should also answer for directly and indirectly owned foreign affiliates.

The questionnaire contains two forms. **Form A** is to be returned in one copy and concern information regarding the company group in Sweden and its operations abroad. Companies that have producing affiliates abroad are asked to answer **form B** as well. For each of the producing foreign affiliates, one copy of form B is also to be filled in. More copies of form B can be obtained from the IUI.

Please also enclose a copy of the **Annual Report 1990** for the company group. Send the forms and the Annual Report in the enclosed, postage free envelope.

V. Rate of exchange

All figures are to be stated in Swedish crowns (SEK) after conversion according to the rates of exchange in the consolidated financial statements of 1990.

VI. Accounting year

All questions in the questionnaire concern the calendar year 1990. Items on the balance sheet should refer to December 31. Companies with broken accounting year should leave information for the accounting year which most closely coincide with the calendar year. If the accounting year covers the period July 1 to June 30, please forward the figures for the accounting year 1989/90. If the company has a broken accounting year, or the period does not cover 12 months, please mention this.

VII. Accuracy in the answers

If you have difficulties in gathering exact information, please make reasonable estimates. Try to make the estimates comparable between different affiliates and countries. If the information provided is highly uncertain, please indicate so under "additional information" in the A- and B forms.

VIII. Explanation to specific questions

Reference to the explanation VIII:1-VIII:5 below is found at the respective question.

VIII:1 The enterprise's main line of business.

Industry code	Industry
01	Mining
02	Food, beverages and tobacco industries
03	Textile, wearing apparel and leather industries
04	Wood and wood products industries
05	Pulp and paper industries
06	Paper products and printing industries
07	Chemical, plastic and rubber industries
08	Non-metallic mineral products industry, except products of petroleum and coal
09	Iron and steel industries
10	Fabricated metal products industry
11	Machinery industry
12	Electronics and electrical machinery industries
13	Transport equipment industry
14	Ship and boat building and repairing industries
15	Industries for measuring and controlling equipment, photographic and optical goods
16	Other manufacturing industries

VIII:2 Codes (1-11) concerning line of business for other operational affiliates abroad.

1: Trade	5: Research and Development	9: Service
2: Agriculture	6: Headquarters/group management	10: Finance
3: Building and construction industry	7: Transportation	11: Other services
4: Electrical and power stations	8: Distribution	

VIII:3 Definition according to the OECD "Frascati Manual" (also used by Statistics Sweden). R&D is a term covering three activities: **basic research, applied research**, and **experimental development** in natural science, technology, medicine, agriculture, science, etc. Social science, e.g. marketing research and research in managing a firm, is not included in this definition. R&D must contain an element of nowellty. Standard design work following established routines, shall not be accounted for as R&D. Both R&D carried out in-house and R&D commissioned to a third party should be included. License payments shall not be accounted for as R&D expenses.

VIII:4 In case information on social costs is not available for the affiliates abroad, please estimate their percentage share of total expenditures on salaries.

VIII:5 The parent company's direct and indirect holding in a foreign affiliate is determined as follows: Assume that 80% of the shares in a foreign affiliate are owned by another foreign company in which the Swedish parent company holds 60%. Then the direct and indirect holding in the foreign affiliate is 60% x 80% = 48%. In this case the Swedish company group's direct holdings is zero. The reason for still naming the foreign affiliate a subsidiary is determined by the majority holding of the second affiliate in the group.

A:1

FORM A CONFIDENTIAL

ACTIVITIES OF SWEDISH MULTINATIONAL COMPANIES ABROAD 1990

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The forms should be returned before 29 November 1991 to the Industrial Institute for Economic and Social Research.
NB Please send a copy of your Group Annual Report for 1990.

Form A: Details of the company/group in Sweden and its interests abroad.

Please read the instructions before filling in the questionnaire.

SECTION I

1. Name and address of the company/parent company:		IUI code (to be filled in by IUI)
2. Contact person: ..... Tel: .....ext: ..... Fax:		
3. The main sector to which the Swedish company/companies in the group belong(s). Give the sector code as defined in instructions VIII:1. NB One code only.	Code	

A:2

4. List below the industrial enterprises situated in **Sweden** with at least fifty employees which joined/left the group in the period 1986-1990, together with other details of these enterprises.
See instructions III and VIII:1

Company name	Sector (acc. to code in VIII:1)	Year joined	Year left	Number of employees at the time of acquisition/divestment	Number of employees in 1990 (if joined)

Continue on a separate sheet if the table is not large enough.

5. The number of **production affiliates** abroad. See instructions III. For each such affiliate, form B should be sent in.	Number 1990

6. Total number of group employees in 1990. Average for the year.	**Worldwide**	**of whom** in Sweden	**of whom** in EC countries

7. Number of employees in **sales affiliates** abroad.
See instructions III. Add up the employees of sales affiliates and specify by country.

Country	IUI code (to be filled in by IUI)	Number of employees 1990

Continue on a separate sheet if the table is not large enough.

8. Details of **other operating affiliates** abroad.
See instructions III and VIII:2.

Country	IUI code (to be filled in by IUI)	Type of business by code in VIII:2	Number of employees 1990

Continue on a separate sheet if the table is not large enough.

A:4

	MSEK 1990
9. External revenues of the **entire** group. Invoiced sales plus other operating revenue. All sales within the group should be eliminated.	
10. External revenue of the Swedish part of the group. External revenues in Sweden plus total invoiced exports. Total invoiced exports is defined as external exports plus sales to foreign affiliates. Exports should be valued FOB.	
11. (a) Total invoiced exports of the Swedish part of the group See definition in question 10.	
of which (b) sales to foreign affiliates.	
12. External revenues outside Sweden of the **entire** group. NB Item 12 = items 9 - 10 + 11a	

13. Additional information.

SECTION II. NB Questions 14-39 should only be answered by groups with production affiliates abroad.

14. Allocate the details given in 9, 10 and 11a above among the group's products/product lines (maximum of ten). State in percentages.

In case of difficulty, first make a rough division of the group's products/product lines (maximum of 10) and then give reasonable estimates in the table.

Do not give details of the names of divisions/business areas since this information is asked for in question 33. If you use ISIC codes to classify your products/product lines, please give these codes instead of the names of products/product lines.

Products/product lines (or ISIC codes)	IUI code (to be filled in by IUI)	Proportion of total group revenues (question 9) %	Proportion of revenues of the Swedish part of the group (question 10) %	Proportion of exports of the Swedish part of the group (question 11a) %
		Total 100 %	Total 100 %	Total 100 %

A:6

15. Allocate the information given in 12 (external revenues outside Sweden of the **entire** group) and 11a (total exports of the Swedish part of the group) among countries/country regions.
The **figures for revenue** relate to the group's total external sales in each country and should include imports to the country and exclude exports from the country. Sales between companies in the group should be eliminated.
The **figures for exports** relate to total exports from Sweden, i.e. both sales to group companies in the country and other exports to the country in question.

Countries/country regions	IUI code (to be filled in by IUI)	External revenues abroad (as in 12) MSEK 1990	Exports from Sweden (as in 11a) MSEK 1990
Belgium			
France			
Italy			
The Netherlands			
Germany (incl. the former East Germany)			
The UK			
Spain			
Portugal			
Greece			
Denmark			
Ireland			
Luxembourg			
Norway			
Finland			
Switzerland			
Austria			
Rest of Western Europe			
The Soviet Union			
Rest of Eastern Europe (excl. the former East Germany)			
The USA			
Canada			
Latin America			
of which Argentina			
Brazil			
Mexico			
Africa			
of which South Africa			
Asia			
of which Japan			
Australia and New Zealand			
Total Should be the same as the replies to questions 12 and 11a.		(= 12)	(= 11a)

A:7

	MSEK 1990
16. (a) Total revenues of the **Swedish** part of the group from licenses, patents, royalties, know-how and management fees Including contributions to cover the costs of R & D and central administration. Excluding payments between Swedish companies in the group. Make reasonable estimates.	
of which (b) income from foreign affiliates.	
(c) income from other foreign companies.	
17. (a) Expenditure of the **entire** group on licenses, patents, royalties and know-how. Excluding payments between companies in the group. Make reasonable estimates.	
of which (b) payments to countries other than Sweden.	

Answer questions 18-22 for **the group as a whole** and in relation to how much of this total amount concerns **Sweden** and **EC countries**.	MSEK 1990		
	The group as a whole	**of which** in Sweden	**of which** in EC countries
18. (a) Capital expenditure by the group Relates to gross investments in machinery, equipment and buildings and should include the initial values of machinery, equipment and buildings for companies acquired in 1990. Acquired companies refers to companies in which the group has acquired at least 50 % of the share capital.			
of which (b) initial values of **machinery, equipment and buildings** for companies acquired in 1990.			
19. Initial values of **total assets** for companies acquired in 1990. See question 18 (a) for the definition of acquired companies.			
20. Group expenditure on training. Relates to company-specific and general training arranged or financed by the group for the employees. Make reasonable estimates.			
21. Group expenditure on marketing. Relates to the group's internal costs for the marketing department etc. and to external costs, such as the purchasing of marketing services and advertising costs. Market investments should also be included, i.e. expenses of a long-term nature such as the cultivation of markets. Make reasonable estimates.			
22. Group expenditure on research and development (R & D). Excluding payments between companies in the group. R & D expenditure refers to both current expenses and depreciation on capital equipment for R & D. Both R & D carried out in-house and R & D commissioned by the affiliate from a third party should be included. In the Sweden and EC columns, state the proportion of total R & D carried out in Sweden and in EC countries. (As defined by Statistics Sweden, see instructions VIII:3.)			

A:8

Answer questions 23, 27-29 and 32 for **the group as a whole** and in relation to how much of this total amount concerns the **Swedish** part of the group and **EC affiliates**. The other questions on this page should only be answered for the **group as a whole**.	MSEK 1990		
	Group as a whole	**of which** in the Swedish part of the group	**of which** in EC group affiliates
23. The value of fixed assets Relates to machinery, equipment and buildings. (a) book value (planned residual value)			
(b) estimated replacement value			
24. Total liabilities (excl. untaxed reserves)		XXXXXXXXX	XXXXXXXX
25. Untaxed reserves		XXXXXXXXX	XXXXXXXX
26. Total equity		XXXXXXXXX	XXXXXXXX
27. Total assets (book value)			

28. Operating income before depreciation			
29. Depreciation according to plan			
30. Total interest expense		XXXXXXXXX	XXXXXXXX
31. Income after financial income and expense		XXXXXXXXX	XXXXXXXX

32. Total expenditure on wages and salaries (incl. fringe benefits). See instructions VIII:4.			

A:9

33. Allocate the information in the table below among the group's five largest divisions/business areas in terms of revenue **and** a residual item for other divisions/business areas (where you have more than five divisions) **and** one item for operations common to the group (i.e. operations which fall outside the divisions, e.g. head office, group management, holding company, real estate management and financing). State in percentages.
Div 1 + 2 + 3 + 4 + 5 + residual item + common to the group = 100 %. If you have fewer than five divisions, leave the extra boxes for the divisions and the residual item empty.
Make reasonable estimates in cases where the information is not easy to allocate.

	Name of division/business area	IUI code (to be filled in by IUI)	Total group revenues (question 9)	Revenues of the Swedish part of the group (question 10)
Div 1			%	%
Div 2			%	%
Div 3			%	%
Div 4			%	%
Div 5			%	%
Residual item for other divisions	XXXXXXXXXX		%	%
Common to the group	XXXXXXXXXX		%	%
Total	XXXXXXXXXX		100 %	100 %

Question 33 continued. NB The same divisions as above.

	Total assets (question 27)		Operating income before depreciation (question 28)		Total expenditure on wages and salaries (question 32)	
	Group as a whole	**of which** in Sweden	**Group as a whole**	**of which** in Sweden	**Group as a whole**	**of which** in Sweden
Div 1	%	%	%	%	%	%
Div 2	%	%	%	%	%	%
Div 3	%	%	%	%	%	%
Div 4	%	%	%	%	%	%
Div 5	%	%	%	%	%	%
Residual item for other divisions	%	%	%	%	%	%
Common to the group	%	%	%	%	%	%
Total	100 %	100 %	100 %	100 %	100 %	100 %

	Worldwide	**of which** in Sweden	**of which** in EC countries
34. The number of those employed in operations common to the group. See question 33 for a definition of this activity.			

A:10

35. List the names of the group's **Swedish production enterprises** in divisions 1-5 (and the residual item) as in question 33. Limit the details to industrial enterprises having at least 200 employees. In the table give the company names by divisions.
Continue on a separate sheet if the table is not large enough.

	IUI code (to be filled in by IUI)	Names of companies in each division	IUI code (to be filled in by IUI)
Div 1			
Div 2			
Div 3			
Div 4			
Div 5			
Residual item for other divisions			

EVALUATION QUESTIONS

36. Give the names of the **four** largest (in terms of revenue) manufacturers in the world in each sector for your **two** largest divisions/business areas (the **two** largest divisions in terms of revenue in question 33). Make reasonable estimates of the world market shares of these manufacturers in each sector.

If you yourself are one of these manufacturers, write the name of your own group and your market share on one line and corresponding information for your three largest competitors on the remaining three lines. In cases where it is difficult to identify a sector, competitors and market shares for your two largest divisions, please make **reasonable estimates**, based on the main sector classification/products of the divisions.

Division 1: the largest in question 33 (= sector 1)		
Names of the four largest manufacturers in sector 1	Market share sector 1	IUI code (to be filled in by IUI)
1.	%	
2.	%	
3.	%	
4.	%	

Division 2: the second largest in question 33 (= sector 2)		
Names of the four largest manufacturers in sector 2	Market share sector 2	IUI code (to be filled in by IUI)
1.	%	
2.	%	
3.	%	
4.	%	

37. Give a breakdown of the revenues of the manufacturers identified in question 36 by region.

Relates to the revenues of manufacturers for the products of each sector. Make reasonable estimates and give percentages.

The four largest manufacturers in sector 1 (as in 36 above)	Breakdown of revenues by region			IUI code (to be filled in by IUI)
	Europe	North America	East Asia	
1	%	%	%	
2	%	%	%	
3	%	%	%	
4	%	%	%	

The four largest manufacturers in sector 2 (as in 36 above)	Breakdown of revenues by region			IUI code (to be filled in by IUI)
	Europe	North America	East Asia	
1	%	%	%	
2	%	%	%	
3	%	%	%	
4	%	%	%	

A:12

38. For the two divisions in question 36, state whether responsibility for profitability is required globally, regionally and/or locally. Place a cross under Yes or No.	Division 1		Division 2	
	Yes	No	Yes	No
(a) Globally				
(b) Regionally (e.g. the North American business, regardless of exactly how this region is defined).				
(c) Locally (e.g. national market or other area for which an organizational unit is responsible.				

39. For each of the activities named below, state to what extent the group coordinates these activities internationally. Answer for the group as a whole and for the two divisions in question 36.
State the degree of international coordination as a percentage between 0 and 100, where 0 relates to total absence of international coordination and 100 relates to complete international coordination.

Activity	The group as a whole	Division 1	Division 2
Manufacture			
Research and development			
Marketing			

B:1
FORM B CONFIDENTIAL

ACTIVITIES OF SWEDISH MULTINATIONAL COMPANIES ABROAD 1990

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The forms should be returned before 29 November 1991 to the Industrial Institute for Economic and Social Research.

Form B: Details of the production affiliate abroad.

Please read the instructions before filling in the questionnaire.

1. Name of the affiliate: ..... Country:	IUI code (to be filled in by IUI)
Parent company of the group:	
The affiliate belongs to the following division/business area: .... If the affiliate belongs to more than one division, state which ones and estimate the proportion of the affiliate's revenue attributable to each division. Use the same names as in question 33 of form A.	
2. (a) Since what year has the affiliate been a production company of the group?	.....
(b) Was the affiliate a sales company of the group before the year mentioned above?	yes ....no ....
(c) Did the affiliate operate as a production company of another group before the year mentioned?	yes ....no ....
	MSEK 1990
3. (a) Total invoiced sales Sales should be stated net, i.e. after deductions for revenue tax, discounts and returns.	
of which (b) goods made or assembled by the affiliate. Make a reasonable assessment. The difference between 3a and 3b is made up of goods which are resold only, without being processed by the affiliate.	
4. (a) Total invoiced exports of 3 (a) Including exports to other companies in the group. Exports should be valued FOB.	
of which (b) exports to Sweden.	
(c) exports to Swedish companies in the group. Make reasonable estimates.	

B:2

	MSEK 1990
5. (a) Imports of goods from the Swedish companies in the group Imports should be valued FOB Sweden. Make reasonable estimates.	
of which (b) goods for resale with no processing by the affiliate.	
(c) goods for processing by the affiliate.	

6. Make-up of the affiliate's production as in 3 (b) above. State the principal products/product lines made by the affiliate, together with the proportion of production held by each.
See question 14 of form A. If possible, use the same names of products/product lines as in question A:14. Give ISIC codes if you used these codes in question A:14 instead of the names of products/product lines.

Products/product lines (or ISIC codes)	IUI code (to be filled in by IUI)	Share of total production (as in 3b) %
		Total 100 %

	MSEK 1990
7. Capital expenditure. Relates to gross investments in machinery, equipment and buildings.	
8. Expenditure on research and development (R & D). Excluding payments between group companies. R & D expenditure refers to both current expenses and depreciation on capital equipment for R & D. Both R & D carried out in-house and R & D commissioned by the affiliate from a third party should be included (as defined by Statistics Sweden, see instructions VIII:3).	

B:3

	MSEK 1990
9. The value of fixed assets Relates to machinery, equipment and buildings. (a) book value (planned residual value)	
(b) estimated replacement value	
10. (a) Total liabilities (excl. untaxed reserves)	
of which (b) long-term debt to the Swedish companies in the group.	
11. Untaxed reserves	
12. Total equity	
13. Total assets (book value)	
14. Proportion of the share capital owned See instructions VIII:5. (a) directly and indirectly by the parent company of the group.	%
(b) directly by the Swedish companies in the group.	%

	MSEK 1990
15. Operating income before depreciation	
16. Depreciation according to plan	
17. Total interest expense	
18. Income after financial interest and expense	
19. (a) Net income for 1990 (after tax).	
(b) Total dividend declared on the net income for 1990.	
(c) Dividend remitted to the Swedish companies of the group (excl. withholding tax). Relates to remittance of the net income for 1990, regardless of when the actual remittance was made.	

20. Total expenditure on wages and salaries (incl. fringe benefits). See instructions VIII:4.	
	Number 1990
21. Number of employees. Average number of employees during the year.	

B:4

22. Additional information.

IUI dissertations

Researchers who have worked on their degree at IUI and the title of their dissertation. (Doctor's degree in economics unless otherwise stated.)

1944–1954

Folke Kristensson (business administration). *Studier i svenska textila industriers struktur* (Studies in the Structure of Swedish Textile Industries). 1946.

Jan Wallander. *Flykten från skogsbygden* (The Exodus from the Forest Regions). 1948.

Erik Dahmén. *Svensk industriell företagarverksamhet* (Entrepreneurial Activity in Swedish Industry). 1950.

Roland Artle. *Svenskt distributionsväsende* (Swedish Distributive Trades). 1952.

Ragnar Bentzel. *Inkomstfördelningen i Sverige* (The Distribution of Income in Sweden). 1952.

1955–1965

Odd Gulbrandsen. *Strukturomvandlingen i jordbruket* (The Structural Transformation in Agriculture). 1957.

John Ekström (licentiate). *Den textila konsumtionen* (The Consumption of Textiles). 1958.

Göran Albinsson-Bruhner (licentiate). *Svensk verkstadsindustri. Struktur och utvecklingstendenser* (The Engineering Industries in Sweden. Structure and Tendencies of Development). 1961.

Lars Nabseth. *Löneökningars verkningar inom industrin. En studie av anpassningsprocessen inom företaget* (The Effects of Wage Increases in Industry. A Study of the Process of Adaptation within the Firm). 1961.

Erik Höök. *Den offentliga sektorns expansion. En studie av de offentliga civila utgifternas utveckling åren 1913–58* (The Expansion of the Public Sector – A Study of the Development of Public Civilian Expenditures in Sweden 1913–58). 1962.

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