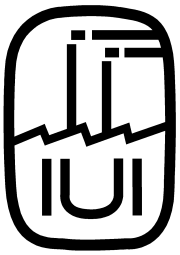

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The Relationship between Domestic and Outward Foreign Direct Investment: The Role of Industry-Specific Effects

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Abstract

Previous research has been inconclusive as regards the effect of outward foreign direct investment (FDI) on domestic investments. In this article we show that this inconclusiveness can be explained at a disaggregated level as a function of the way industries are organized. Based on a simple model including monitoring and trade costs, we argue that a complementary relationship can be expected to prevail in vertically integrated industries, whereas a substitutionary relationship can be expected in horizontally organized production. The empirical analysis confirms a significant difference between the two categories of industry as regards the impact of outward FDI on domestic investment. The results may thus have profound policy implications.

JEL: F12, F21, F23, G34

Keywords: FDI, gross domestic investment, industry-specific effects, monitoring costs, trade costs.

Introduction

The unprecedented increase in foreign direct investments (FDI) that has occurred over the last couple of decades frequently arouses political concern as regards the effects on home economies.[1] In particular, the fear of "lost" jobs and a fall in wages is often brought up as an argument against outward FDI and seems to command considerable political clout. A key ingredient in formulating an adequate economic policy is an understanding of the relation between outward FDI and gross domestic investment (GDI). Despite the very close link between this issue and the oft-investigated relation between export and FDI, few studies exist of the FDI-GDI relation.[2] The complementary relationship between foreign production and exports suggests the presence of a similar relationship between FDI and home-country investment. Hence, rising exports should lead to an increase in the domestic production capacity. However, the existing empirical findings are ambiguous, with some studies concluding that FDI replaces home country investment, and others suggesting a complementary relationship between the two.

The first papers to address the impact of FDI on home-country investment appeared in the 1970s (Herring and Willett, 1973; Noorzoy, 1980). Using time series data at the industry level for US firms during the early 1970s, these studies concluded that a *positive* relationship prevailed between investment at home and abroad. On the other hand, with the exception of Borensztein et al (1998), more recent studies have shown a *negative* relationship between FDI and home-country investment (Belderbos, 1992; Stevens and Lipsey, 1992). In the second of these studies it is argued that the firm's capital constraints would mean that a foreign direct investment crowded out domestic investment.

Although these later studies were more technically sophisticated, they still suffered from data restrictions as their analyses comprised a limited number of firms, industries and years only.[3] To remedy this weakness, Feldstein (1995) made use of aggregate industry data and

came to the conclusion that a one-to-one dollar negative relation exists between foreign and domestic investment. Hence, every dollar invested abroad means one dollar less invested at home. In other words, a full substitutionary effect was found when the analysis was extended to comprise total flows.

A common feature of the few existing studies is their ignorance of the part played by industry-specific effects. To our knowledge, with one exception, there have been no published studies on the analysis of the home-country effects of FDI, where such industry-specific characteristics have explicitly been taken into account.[4] A recent study, Hejazi and Pauly (2003), which also refers to the scarcity of studies on the relation between outward FDI and gross domestic investment, addresses a similar issue. Its focus is different from ours, however, as it concentrates on the relationship between the underlying motive to undertake FDI and the ensuing effects of FDI on domestic gross fixed capital formation. Here, on the other hand, we look at differences in the way firms and industries organize production and how these affects the relationship between FDI and domestic gross fixed capital formation. Hejazi and Pauly, although finding a positive link between outward FDI to the US and Canada and a negative link regarding the rest of the world, conclude that one cannot predict whether growth in outward FDI will increase or decrease domestic gross fixed capital formation.

Adopting a simple two-industry model we show that industry-specific factors do influence the relationship between FDI and domestic gross fixed capital formation. More precisely, a *substitutionary* relationship between foreign and home-country investment can be expected for R&D-intensive, horizontally organized industries (henceforth referred to here as the Schumpeter industry), whereas a *complementary* investment relationship prevails for vertically integrated industries, originating in traditional comparative advantage factors (referred to here as the Heckscher–Ohlin industry). We formulate our hypotheses on the basis of these inherent differences between industries.

Applying cluster analysis to the R&D intensities in Table 1 gives good reason to distinguish between Schumpeter and Heckscher–Ohlin industries.[5] The first group, the Schumpeter industries, comprises the chemical industry (ISIC 35) and the industry for fabricated metal products, machinery and equipment (ISIC 38), whereas all remaining manufacturing industries fall into the second group, the Heckscher–Ohlin industries. The difference between the two groups' mean value for R&D intensity, defined as expenditure on R&D divided by value-added, is highly significant.

Insert Table 1

In the econometric analysis we apply a panel regression technique with fixed industry effects for the period 1982–2001. The empirical analysis exploits a unique Swedish data set, that is cross-tabulated by industry and country. Sweden is recognized as one of the countries with the greatest number of multinational corporations (MNCs) per capita that has long been engaged in foreign operations (UNCTAD 2002). We therefore contend that the Swedish case serves well to illustrate the question raised in this paper, and that the results can be generalized to other countries even though the magnitude may differ across countries.

The difference between the two industries in the Swedish context is shown in Figure 1. FDI is obviously undertaken predominantly by firms in the more R&D-intensive Schumpeter industries, suggesting strong sector-specific features in their investment patterns. Thus, to understand the relationship between FDI and home-country investment, it is necessary to disaggregate the analysis to the industry level. As regards geographical proximity – which influences trade costs and knowledge about foreign markets – Swedish firms' FDI has occurred predominantly within the European Union (EU), as can be seen in Figure 2.

Insert Figures 1 and 2

The rest of the paper is organized as follows. The following section provides the theoretical framework and introduces our hypotheses. Thereafter we present the empirical model to test the relationship between FDI and gross domestic capital formation, and the data used in the analysis. The next section gives the results of the estimations. The paper closes with some concluding remarks.

Theoretical framework and hypotheses

Transaction-cost theory explains why multinational firms engage in overseas investment but it is not sufficient as a tool for distinguishing between horizontally and vertically organized production structures.[6] Nor does transaction-cost theory explain the relation between FDI and gross domestic capital formation. Instead, we have to merge the explanations provided by the transaction-cost theory with industry-specific features in order to understand why firms and industries differ, particularly with respect to the relation between FDI and home-country investment. To our knowledge this has not previously been done. The importance of taking industry-specific characteristics into account is demonstrated in a simple model below as an underpinning of the hypotheses formulation that ends this section.

Assume a world consisting of two equal-sized countries, home and foreign, each hosting a Schumpeterian and a Heckscher–Ohlin industry.[7] Markets are characterized by imperfect competition, i.e., they are exposed to increasing returns to scale, and firms compete by offering differentiated products. Product variety is more pronounced in the Schumpeter than in the Heckscher–Ohlin industry, however, for reasons that will be elaborated below.

Firms in the two industries display structural and organizational differences. As always, features of horizontally and vertically integrated production structures apply to both industries.[8] All firms employ a composite intermediate product containing headquarter services – predominantly knowledge originating in the firm's R&D or marketing activities –

as well as physical products. As shown by Williamson (1985), proprietary assets originating in knowledge-enhancing activities such as R&D generate horizontally organized production structures, while the internalization of intermediate products fosters vertically integrated structures (Perry,1989; Markusen,1995).[9] The non-excludability of proprietary assets (R&D) implies that intangible knowledge-intensive intermediates can be used by several units simultaneously, whereas more physical intermediate products can only be used at one unit. R&D is produced by employing skilled labor, whereas physical investment (machinery, buildings, etc.) is required in the production of the durable part of intermediates.

The composition of the intermediate product varies between the two industries. In the Schumpeter industry the intermediate product is more R&D-intensive as compared to the Heckscher–Ohlin industry. The latter employs an intermediate good that is extracted and processed at the lower end of the value-added chain, i.e. it has a proportionately larger content of raw material. The more intensive use of a (homogenous) raw-material-based intermediate product also implies a lower degree of product differentiation in the Heckscher-Ohlin industry as compared to the Schumpeter industry.[10] Hence, the competitiveness of firms belonging to the Schumpeter industry is based to a larger extent on R&D activities, while the Heckscher–Ohlin industry derives its strength from traditional, country-based, comparative advantages.

Firms supply both the home market and the foreign market, either through exports or through foreign direct investment. The profit-maximizing firm makes its choice depending on a set of factors specific to the firm, the industry and the country. Classified in accordance with the OLI-taxonomy these relate to the firm’s ownership advantages (proprietary assets originating in knowledge-producing activities), to its the relative location advantages (production costs, etc.), and to whether production can occur through arm’s length contracts or whether it must be internalized (Dunning, 1977; Markusen, 1995).

To clarify our argument, let us consider the (hypothetical) case in which firms use either a pure R&D intermediate product (Schumpeter firms) or a lightly processed raw-material intermediate (Heckscher–Ohlin firms). It is assumed that economies of scale are exhausted in existing plants and to expand production firms have to establish a new production unit either abroad or in the home country. If firms decide to invest abroad, they will experience positive monitoring costs due to the increased geographical dispersion of production, whereas home-country production imposes no such costs.[11] On the other hand, if an export strategy is preferred, trade costs (consisting of transportation costs and trade barriers) are incurred.[12]

In the profit-maximizing firm in the respective industries, the choice of strategy will then be determined by the relation between costs associated with foreign production and exporting costs. In the vertically structured Heckscher–Ohlin industry the following first-order conditions determine whether an increase in production will occur overseas:

$$t > \lambda\tau + m/(1+q^F)\text{, the firm will choose an FDI-strategy}$$

$$t < \lambda\tau + m/(1+q^F)\text{, the firm will choose an export strategy} \qquad (1)$$

$$t = \lambda\tau + m/(1+q^F)\text{, the firm is indifferent to production site,}$$

where t and τ denote unit costs of exporting final and intermediary goods respectively, the expression $m/(1+q^F)$ represents a marginal increase in monitoring costs (m), which are assumed to rise at a decreasing rate of foreign production (q^F). Finally, λ originates from a simplifying assumption in the model and stands for the share of intermediate products in the final product (for the full model, see Appendix).

As shown in the first part of expression 1, if the cost of exporting the final good exceeds the increased cost of monitoring a multi-national production structure plus the cost of exporting the home-country intermediates to a foreign production unit, then the firm will invest abroad to expand its production of the final good. Investment in the home country will be limited to the production of intermediates. On the other hand, if the relative costs of FDI as compared to export go in the other direction, the firm will choose an export strategy and investments will increase in the home country at both stages. Finally, if costs are identical for the two alternatives, the firm will be indifferent as between exporting or setting up a foreign unit. The important finding is that irrespective of whether the firm adopts an export or an FDI strategy, domestic gross fixed capital formation will increase in the vertically organized Heckscher–Ohlin industry.

Let us now consider the horizontally integrated firms in the Schumpeter industry. As in the Heckscher–Ohlin case, the firms can choose either an FDI or an export strategy. However, in the Schumpeter industry there is no geographical ties between the different production stages. Hence, the decision about where to increase production depends on the relation between the trade and monitoring costs, given identical production technologies (and production costs) in the respective countries.

As in the Heckscher–Ohlin industry, a comparison of the increase in the profits of production at home with the profits generated by FDI demonstrates clearly that the relation between trade and monitoring costs will determine the strategy of the firm. Thus:

$$
\begin{aligned}
&t > m/(1+q^F)\text{, the firm will choose an FDI-strategy} \\
&t < m/(1+q^F)\text{, the firm will choose an export strategy} \qquad (2) \\
&t = m/(1+q^F)\text{, the firm is indifferent to production site.}
\end{aligned}
$$

This simple model illustrates the way different organizational structures within industries affect the relationship between gross domestic capital formation and FDI. In the vertically organized Heckscher–Ohlin industry the link with the home-country-based production of intermediates implies that an increase in the final-stage production necessarily increases home-country investment. This holds, irrespective of whether the firm expands production of the final goods abroad or at home. The Schumpeter-industry's production is more footloose and less entangled with the home country. Hence, we confer that FDI substitutes for home-country investment, and the net effect on an economy depends on the composition of its industry.

In light of the above model the following hypotheses regarding the relation between FDI and domestic gross fixed capital formation in the respective industries can then be formulated and tested:

H1: FDI in the Heckscher–Ohlin industry is expected to have a complementary and positive impact on domestic gross fixed capital formation due to its vertical production structure whereby one stage is tied to the home country.

H2: FDI in the Schumpeter industry is expected to have a substitutionary and negative impact on domestic gross fixed capital formation due to its horizontal production structure.

H3: FDI in the more distant market can be expected to exert a negative impact on domestic gross fixed capital formation due to high trade costs.

Methodology

We employ a panel regression technique with fixed industry effects to test our hypotheses. All regressions are estimated using first differences in export (EXP), domestic gross fixed capital

formation (GFCF) and foreign direct investment to the EU (FDIEU) and to the rest of the world (FDIRW). This is justified on the grounds that first differences best mirror changes in investment patterns, while absolute levels largely reflect the maintenance of an existing capital stock. Percentage changes would be another feasible variable specification. There are severe technical problems in using this specification, however, since in some years foreign direct investment tends to be very close to zero, which often gives rise to unreasonably large percentage changes the following year.

The model to estimate is:

$$\begin{aligned} GFCF_{i,t} - GFCF_{i,t-1} &= \alpha_i + \beta_1 \left(FDIEU_{i,t} - FDIEU_{i,t-1} \right) + \beta_2 \left(FDIRW_{i,t} - FDIRW_{i,t-1} \right) \\ &+ \beta_3 \left(FDIEU_{i,t} - FDIEU_{i,t-1} \right) \times R\&D_{i,t} + \beta_4 \left(FDIRW_{i,t} - FDIRW_{i,t-1} \right) \times R\&D_{i,t} \\ &+ \beta_5 \left(EXP_{i,t-1} - EXP_{i,t-2} \right) + \beta_6 R\&D_{i,t} + \beta_7 TTAX_t + \beta_8 RULC_t + \beta_9 GROWTH_t \\ &+ \beta_{10} TDUM1986 + \beta_{11} TDUM1995 + \varepsilon_{i,t} \end{aligned} \quad (3)$$

where i and t denote industry and time respectively. The error term ε is expected to be independently and identically distributed with mean zero and variance σ^2.

In order to test these hypotheses we include among the explanatory variables both foreign direct investment and an interaction variable between foreign direct investment and R&D intensity, where R&D intensity (R&D) is defined as expenditure on R&D divided by value added. We expect the former to have a positive impact on domestic investment while the effect of the latter is expected to be negative.

We also control for a number of variables that have been shown in previous studies to influence investment, as well as its distribution across countries. In addition to FDI, foreign markets can also be supported by exports. Exports, lagged one year, are therefore included in the regressions to isolate the effect of FDI on home-country investment. We expect exports to

be positively associated with home-country investment (Lipsey and Weiss, 1984; Blomström and Lipsey, 1989).

Numerous studies have concluded that R&D is positively related to firms' internationalization.[13] However, R&D outlays that generate new products or new (complementary) production processes may also have a positive impact on domestic gross fixed capital formation (Hejazi and Pauly, 2003). Hence, we cannot anticipate which sign this variable will take: it can influence home-country investments in both directions.

We also control for factors that can be seen as "L" factors in the OLI framework (Dunning, 1977). Hence, we include the percentage change in the relative unit labor cost (RULC) as a control variable. Increases in relative production costs in Sweden compared to host countries are expected to have a negative effect on home-country investments. Other "L" variables, such as the overall tax pressure in Sweden (TTAX) defined as total taxes in relation to GDP, are related to economic policy. From this variable we expect a negative influence on domestic investments (Dunning, 1993; Loree and Guisinger, 1995). Moreover, we include a home-country growth variable (percentage change in Swedish GDP) and two relative growth variables (GROWTH) to account for business-cycle effects that are not fully correlated over time or regions. The relative growth variables are defined as Swedish GDP growth in relation to the GDP growth in the EU and in the US. Higher growth rates are expected to have a positive impact on domestic investment (Sethi et al, 2003). We have also inserted time dummies to capture the effect of the enlargement of the EU in 1986 and 1995 (TDUM1986 and TDUM1995).

The choice of time period covered, 1982 to 2001, has been governed by the availability of data.[14] Data on export, R&D intensity, and domestic and foreign investment is distributed on two-digit ISIC code (rev.2)[15] for the manufacturing sector, whereas all remaining variables are country-specific. Tables 2 and 3 provide a detailed description of the variables and the

correlation matrix. Data on foreign direct investment has been gathered from the Swedish Central Bank, while all the remaining variables are derived from various OECD databases.

Insert Tables 2 and 3

To reduce somewhat the effect of the highly volatile investment pattern shown by firms that grow mainly through the acquisition of other firms, we have estimated the model on a basis of three-year moving averages. However, this also means introducing autocorrelation in the error term. We address this issue by adopting the methods presented by Baltagi and Li (1991).

Results

The results of the regressions are presented in Table 4. Foreign direct investment to the EU is positive and highly significant in all the regressions. However, as is evident from the interaction variable between foreign direct investment and R&D intensity, the effect differs significantly between Schumpeter (R&D-intensive) and Heckscher–Ohlin industries.[16] As regards the EU, the estimated coefficient for this interaction variable has the expected negative sign and is also highly significant in all the regressions. Hence, a substitution effect between foreign direct investment and domestic gross fixed capital formation emerges for more R&D-intensive production. More precisely, this occurs when the R&D expenditure exceeds about 20 percent of value added. From Table 1 we can see that this is the case for the chemical industry (ISIC 35) and for the industry for fabricated metal products, machinery and equipment (ISIC 38), i.e. our Schumpeter industries. For all other industries the R&D intensity is well below that breaking- point.

Insert Table 4

This supports our hypotheses of industry-specific effects related to the way production is organized: a complementary effect is obtained between foreign and domestic investment in

more vertically integrated industries, whereas a substitutionary effect seems to prevail for industries characterized by more horizontally integrated structures.

Foreign direct investment to the rest of the world – (FDIRW) – has an expected negative sign but fails to reach significance. A likely explanation is that higher trade costs to distant markets promote FDI, but that the links with the home country – also for reasons of trade costs – are much weaker. The interaction variable between FDIRW and R&D intensity is also insignificant. Regression diagnostics reveal high correlation between the interaction variable and FDIRW, something that could affect the estimation of these coefficients. Even so, excluding one of these variables from the regressions still yields no significant results for the other variable.

Turning to the control variables, we find as expected lagged export to have a positive effect on domestic investment. The effect is significant in all regressions, whereas the R&D-intensity variable receives less support in explaining domestic investment. The relative unit labor cost has an expected negative sign, albeit not significant at an acceptable level. Overall tax pressure has a negative and significant impact on domestic investment. Finally, all three growth variables have the anticipated positive sign and are also strongly significant. In general, the explanatory power of the regressions is satisfying with R^2-values ranging from 0.16 to 0.48.

The regressions provide strong support for the assertion that industry-specific effects must be taken into consideration when analyzing the effects of foreign direct investment on home-country investments. Moreover, this also explains the seemingly inconclusive results in previous studies, that is to say these are likely to have been reflecting differences in the industrial structure.

Conclusions

On the basis of a simple model of the relationship between FDI and gross domestic fixed capital formation we have argued that industry-specific effects have to be considered for a full understanding of this relationship. Our empirical examination of these effects provides strong support for the role they play. We suggest that these differences across industries represents one likely explanation of the seemingly inconclusive results in previous studies as regards the impact of FDI on home-country investments, whereby a positive relationship has been shown by Herring and Willett (1973), Noorzoy (1980) and Borensztein et al (1998); a negative relationship has been shown by Belderbos (1992), Stevens and Lipsey (1992), Feldstein, (1995); and no relationship has been found by Hekazi and Pauly (2003).

We see FDI essentially as a mechanism that can be expected to foster an improved allocation of capital likely to benefit both the home and host countries. At the same time, we would like to stress the importance in this field of research of disaggregating to the industry level in order to identify the forces that influence the effect of FDI on home countries. Differences in industrial structures across countries imply that the effects of FDI on indigenous investments will also differ. A substitution effect between outward FDI to neighboring regions was here found to emerge for industries with R&D expenditure exceeding 20 percent of value added. Thus in a dynamic perspective, a relative change in the industrial structure whereby, for instance, the share of the Schumpeter industries declines, implies that there will be an increase over time in the likelihood of a positive relationship between FDI and home-country investment on an aggregated level.

Focusing on the relationship between domestic and foreign direct investment at an aggregate level will also be inadequate in the economic policy context. Disaggregation to the industry level with a view to understanding the home-country effects of FDI can be seen as instrumental for adequate policy-making. A positive relationship at the aggregate level

between FDI and home-country investment might suggest a policy differing from that required by the underlying negative relationship in the Schumpeter industries. An increasingly positive relationship at the aggregate level could signal that the country is drifting away from the knowledge-intensive global position it desires. A persistent erosion of knowledge and skill may be extremely hard to reverse later, particularly if the future location of a firm is governed by existing clusters, for example to take advantage of R&D spillovers. Ignorance on the part of politicians about industry-specific effects on the relationship between FDI and domestic gross fixed capital formation may thus have long-term effects on production structure, growth and welfare.

Table 1. R&D expenditure as a percentage of value added 1981, 1986, 1991, 1996 and 2001, distributed on two-digit ISIC code.

Industry	ISIC rev.2	1981	1986	1991	1996	2001
Food, Beverages and Tobacco	31	2.2	2.3	1.8	0.8	0.7
Textile, Wearing Apparel and Leather	32	1.3	0.9	1.4	1.3	1.2
Wood and Wood Products, Including Furniture	33	0.3	0.5	0.7	0.8	1.5
Paper and Paper Products, Printing and Publishing	34	2.4	3.0	4.0	2.2	1.1
Chemicals and Chemical, Petroleum, Coal, Rubber and Plastic Products	35	8.2	10.1	14.3	18.0	22.7
Non-Metallic Mineral Products	36	2.3	1.7	1.2	2.3	1.2
Basic Metal	37	2.6	1.8	1.0	0.7	1.9
Fabricated Metal Products, Machinery and Equipment	38	11.5	17.2	21.1	21.1	33.3
Other Manufacturing Industries	39	1.3	1.3	0.3	0.3	0.4

Source: Own calculations based on data from the OECD.

Table 2. Description of data 1982-2001

Variable	Description	Mean	Standard deviation	Min	Max
GFCF	Domestic gross fixed capital formation in Sweden, millions of Swedish Kronor, 1995 prices, industry level[17]	6,824	6,706	319	27,359
FDIEU	Flows of Swedish outward direct investment to the EU, millions of Swedish Kronor, 1995 prices, industry level	1,102	4,648	-26,858	26,302
FDIRW	Flows of Swedish outward direct investment to the rest of the World, millions of Swedish Kronor, 1995 prices, industry level	1,475	5,113	-10,336	36,075
R&D	Expenditure on R&D divided by value added in Sweden, industry level[18]	5.0	7.0	0.2	33.3
EXP	Swedish export, millions of Swedish Kronor, 1995 prices, industry level	49,478	68,085	3,440	377,314
TTAX	Total taxes in Sweden as percentage of GDP	50.8	2.2	47.6	54.2
RULC	Index of relative labor cost for Sweden, percentage change	-2.1	8.5	-28.6	13.1
GROWTH (in Sweden)	Percentage change in Swedish GDP	2.1	1.9	-1.8	4.6
GROWTH (relative the EU)	Percentage change in Swedish GDP divided by corresponding growth in the EU	1.1	1.3	-1.4	5.6
GROWTH (relative the US)	Percentage change in Swedish GDP divided by corresponding growth in the US	0.8	1.1	-0.7	4.5

Table 3. Correlation matrix of data, 1982–2001.

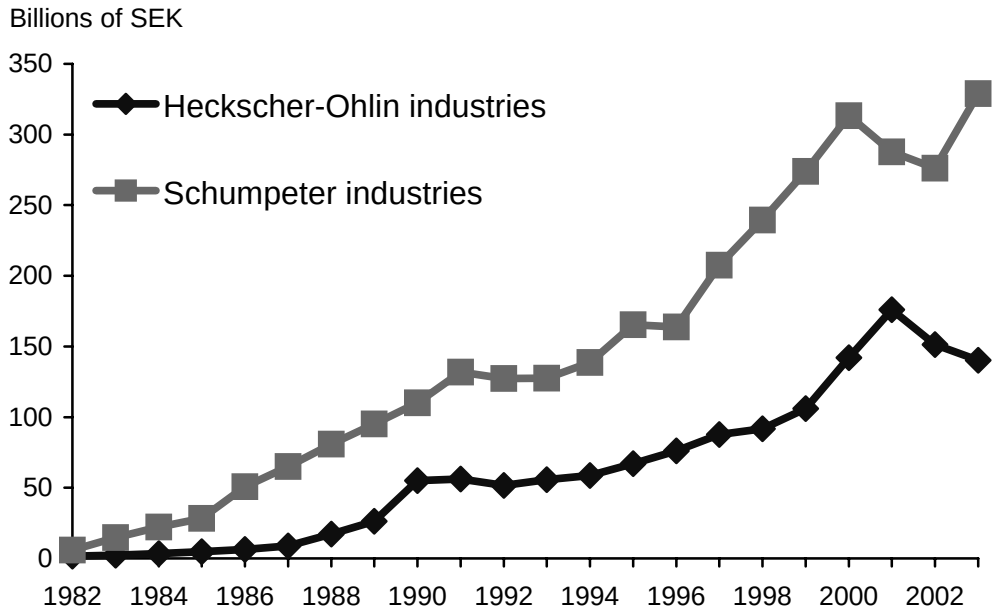
									GROWH in		
		GFCF	FDIEU	FDIRW	R&D	EXP	TTAX	RULC	Sweden	rel. the EU	rel. the US
	GFCF	1.00									
	FDIEU	0.33	1.00								
	FDIRW	0.50	0.21	1.00							
	R&D	0.69	0.07	0.44	1.00						
	EXP	0.86	0.25	0.65	0.82	1.00					
	TTAX	0.15	0.18	0.07	0.02	0.07	1.00				
	RULC	0.11	0.09	-0.02	-0.02	-0.01	0.25	1.00			
GROWH in	Sweden	0.11	0.07	0.16	-0.03	0.09	0.13	0.33	1.00		
	rel. the EU	-0.03	-0.02	0.02	0.01	0.02	-0.31	-0.65	0.05	1.00	
	rel. the US	0.11	0.01	0.07	0.05	0.10	0.43	0.17	0.18	-0.23	1.00

Table 4. Results from panel estimation for the period 1982-2001. Dependent variable: Domestic gross fixed capital formation.

Variable	(1)	(2)	(3)	(4)	(5)
Constant	-15 (-0.25)	6,026*** (5.77)	8,092*** (7.92)	5,812*** (5.50)	8,827*** (8.07)
FDI to the EU	0.1948*** (4.24)	0.1587*** (3.97)	0.1410*** (3.69)	0.1400*** (3.55)	0.1334*** (3.38)
FDI to the rest of the world	-0.1601 (-1.43)	-0.1315 (-1.37)	-0.1231 (-1.35)	-0.1076 (-1.15)	-0.0946 (-1.01)
Interaction between FDI to the EU and R&D intensity	-0.0075*** (-2.86)	-0.0073*** (-3.18)	-0.0067*** (-3.03)	-0.0064*** (-2.83)	-0.0060*** (-2.66)
Interaction between FDI to the rest of the world and R&D intensity	0.0073 (1.32)	0.0055 (1.14)	0.0048 (1.05)	0.0041 (0.87)	0.0034 (0.74)
Export, lagged one year		0.1307*** (6.88)	0.1001*** (5.17)	0.1038*** (5.16)	0.1025*** (5.16)
R&D intensity		-137 (-1.39)	-95 (-1.10)	-111 (-1.28)	-117 (-1.35)
Total taxes, percentage of GDP		-109* (-1.80)	-161*** (-2.76)	-112* (-1.93)	-170*** (-2.82)
Relative unit labor cost, percentage change		-5.25 (-0.37)	-7.40 (-0.55)	-7.82 (-0.57)	-4.92 (-0.36)
Growth in Sweden			234*** (3.92)		
Growth in Sweden relative to growth in the EU				394*** (3.05)	
Growth in Sweden relative to growth in the US					508*** (3.31)
Time dummy for 1986	271 (1.35)	380* (2.20)	397** (2.42)	360** (2.13)	331* (1.96)
Time dummy for 1995	393* (1.90)	88 (0.41)	-50 (-0.24)	77 (0.36)	-10 (-0.04)
ρ	0.70	0.67	0.66	0.66	0.65
R^2	0.16	0.42	0.48	0.46	0.46
F-value	4.05***	8.88***	10.38***	9.45***	9.71***
No of obs	144	144	144	144	144

Note: t-statistics in parenthesis. *, ** and *** denote statistical significance at the 10, 5 and 1 percentage level respectively. Reported constant refers to the average fixed effect; ρ is the estimated autocorrelation coefficient used in transforming the data prior to the estimations. We also tried to control for industry-level import. Due to the high correlation with our export variable, import did not achieve any significance and is therefore not included in the regressions reported here.

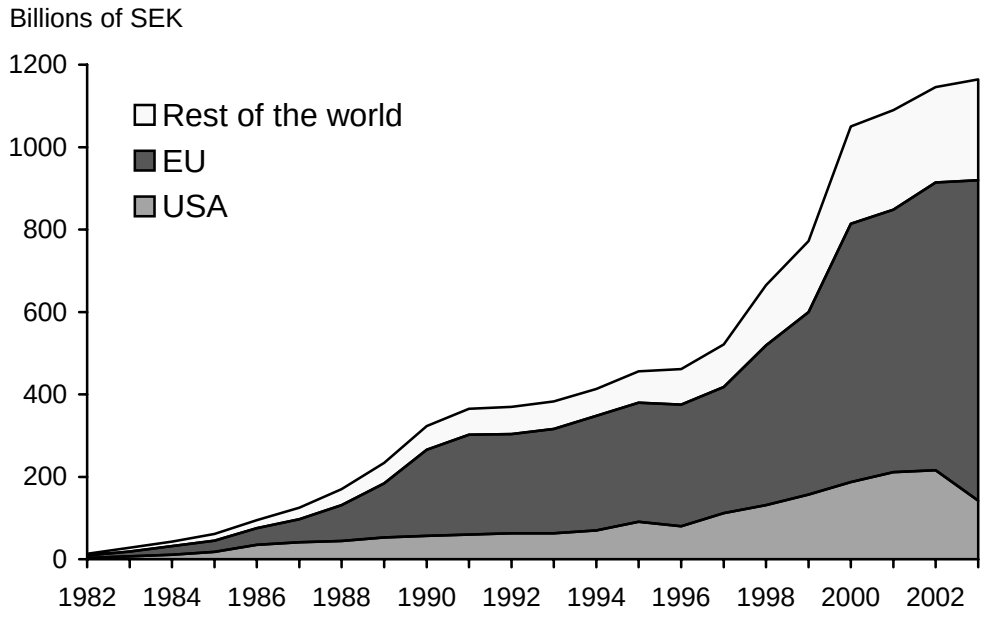
Figure 1. Accumulated total Swedish FDI in Heckscher–Ohlin industries and Schumpeter industries 1982–2003, 1995 prices.



Source: Own calculations based on data from the Swedish Central Bank and the OECD.

Note: Flows are accumulated from 1982 and onwards, hence they start from zero in 1981. The Schumpeter industries comprise the chemical industry (ISIC 35) and the industry for fabricated metal products, machinery and equipment (ISIC 38) whereas the Heckscher–Ohlin industry consists of all other manufacturing industries. This classification is based on a cluster analysis of R&D intensity.

Figure 2. Accumulated outward flows of Swedish FDI to the EU, the United States and the rest of the World 1982–2003, 1995 prices.



Source: Own calculations based on data from the Swedish Central Bank and the OECD.

Note: Flows are accumulated from 1982 and forward, hence they start from zero in 1981.

Appendix

The profit maximization of a representative firm in the Heckscher–Ohlin industry can be described in the following way:

(A.1) $$\pi = pq_{FP} - c_{FP}q_{FP} - c_{IP}q_{IP} - tq_{FP}^{EXP} - \tau\ q_{IP}^{EXP} - m\ln\left(1+q_{FP}^{F}\right) - F\ ,$$

where subscripts *FP* and *IP* denote the final and intermediate stage, respectively, and superscript *EXP* and *F* denote export and production abroad, while *p* and *q* equal unit price and quantity. Variable production costs are represented by c_{IP} and c_{FP}, where c_{FP} excludes costs for intermediary goods. The unit costs of exporting final and intermediary goods are denoted by *t* and τ. The expression $m\ln\left(1+q_{FP}^{F}\right)$ in equation (1) represents monitoring costs, which are assumed to increase at a decreasing rate with foreign production. Finally *F* refers to fixed costs.

If we assume that production of the intermediary product can be expressed as a linear function of the final stage production, i.e.:

(A.2) $$q_{IP} = \lambda\ q_{FP}$$

then,

(A.3) $$\pi = pq_{FP} - cq_{FP} - tq_{FP}^{EXP} - \lambda\tau\ q_{FP}^{F} - m\ln\left(1+q_{FP}^{F}\right) - F\ ,$$

where $c = \left(c_{FP} + \lambda\ c_{IP}\right)$.

Consider the alternative where production takes place at home and final goods are exported. The first-order condition is,

(A.4) $\partial\pi / \partial q_{FP}^{EXP} = p - c - t = 0$

(A.5) $p = c + t$.

The corresponding condition for an increase in foreign production is:

(A.6) $\partial\pi / \partial q_{FP}^{F} = p - c - \lambda\tau - m/(1 + q_{FP}^{F}) = 0$

(A.7) $p = c + \lambda\tau + m/(1 + q_{FP}^{F})$.

Profit maximization across the potential locations applies when the marginal profit of increased investment in production capacity at home equals the marginal profit of an increase in production capacity abroad. Hence, equalizing these two expressions yields:

$t = \lambda\tau + m/(1 + q^{F})$, the firm is indifferent to production site

(A.8) $t > \lambda\tau + m/(1 + q^{F})$, the firm will choose an FDI-strategy

$t < \lambda\tau + m/(1 + q^{F})$, the firm will choose an export strategy

Turning to the Schumpeter industry, profit maximization of a representative firm can be described as:

(A.9) $$\pi = pq - cq - tq^{EXP} - m\ln\left(1+q^{F}\right) - F$$

Increasing production at home and exporting the final product gives rise to the following first-order condition:

(A.10) $$\partial\pi / \partial q^{EXP} = p - c - t = 0$$

(A.11) $$p = c + t\,.$$

The corresponding condition for an increase in foreign production is:

(A.12) $$\partial\pi / \partial q^{F} = p - c - m/(1+q^{F}) = 0$$

(A.13) $$p = c + m/(1+q^{F})\,.$$

Equalizing these two expressions yields,

$t = m/(1+q^{F})$, the firm is indifferent to production site

(A.14) $t > m/(1+q^{F})$, the firm will choose an FDI-strategy

$t < m/(1+q^{F})$, the firm will choose an export strategy

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Notes

[1] See for instance UNCTAD (2002) regarding levels and change in FDI.

[2] Most articles point to a complementary relationship between FDI (foreign production) and trade (Lipsey and Weiss, 1984; Brainard, 1997 and Hejazi and Safarian, 2001). In the case of Sweden, the country we are focusing on in this paper, this complementary relationship has also been confirmed (see e.g., Swedenborg 1979, Blomström, Lipsey and Kulchycky, 1988, Blomström and Lipsey 1989). Svensson (1996) reaches the opposite conclusion and concludes that previous studies have not taken exports to third country into account. For a survey of this strand of literature, see e.g. Caves (1996).

[3] For instance, Stevens and Lipsey's study was based on a sample of seven U.S. multinationals for a period of 20 years, whereas Belderbos' study covered Dutch food and metal/electronics companies for the period 1978–84.

[4] The exception is Braunerhjelm and Oxelheim (1996, 2000), focusing on the adjustment of production facilities abroad and at home as a specific result of the creation of the EU inner market.

[5] The cluster analysis implemented is an iterative, partitioning process, which we have implemented to identify two distinct groups among the industries, based on their R&D intensity (see Kaufman and Rosseeuw, 1990). The method is designed to find groups that are as homogenous as possible within a larger population.

[6] See Caves (1996, Ch. 3) for numerous references on transaction costs, internalization and FDI, and firms' organization. Market factors and economies of scale are, for instance, other factors that influence the organization of production.

[7] To simplify, we assume countries to be identical in size so as to emphasize the industry difference. Abandoning this assumption would not affect the qualitative conclusions as regards the industry differences, but would affect the degree to which firms engage in overseas production.

[8] See Braunerhjelm (1998) for a description and an analysis of vertically and horizontally organized Swedish industries.

[9] Perry (1989) makes a detailed overview of the literature where it is shown that R&D is a robust predictor of horizontally integrated production structures. Markusen (1995) summarizes a number of papers on multinational firms, countries' factor abundance, the international distribution of production, and firms' organization.

[10] Examples are pulp that is used to produce different kind of paper products, or different ways of processing to purify the steel, etc.

[11] Penrose (1959) has shown how, generally speaking, the firm's growth is linked to managerial constraints.

[12] Trade costs can be expected to differ across industries and products, however. The more intangible the good, the lower the trade costs. Consequently, headquarter services in the Schumpeterian industry can be exchanged internationally incurring low trade costs, whereas intermediates used in the Heckscher–Ohlin industry are always exposed to higher trade costs. These differences across industries and products will influence the location decision – i.e., whether investment will be made in the home country or abroad. We disregard such effects here.

[13] See for instance Buckley and Pearce (1979), Lall (1980) and, although with some weaker results, Brainard (1997).

[14] Data for FDI is available for 1982-2003, while both R&D and domestic investment is available only up to 2001. This limits the years accessible for the estimations to 1982-2001.

[15] We would prefer to have conducted the empirical analysis at a more disaggregated level, but data restrictions typical of small countries with few firms in more disaggregated cells prevent such an analysis.

[16] More precisely, this follows from the combined effect of the interaction variable and the significant difference in R&D intensity between the two industries.

[17] GFCF includes investments in machinery and buildings before depreciation. Inward FDI proximity affects ownership and is assumed to have a minor impact on annual capital formation.

[18] The OECD presents R&D data for Sweden biannually. We have therefore interpolated this data by cubic splines in order to get data at an annual basis.