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Foreign Direct Investment and Productivity Spillovers In Swedish Manufacturing[Ψ]

by

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Abstract

Based on a panel of data for Swedish manufacturing firms in 1990-2000, this paper finds strong evidence for the existence of positive spillover effects from inward FDI. The presence of foreign ownership in the same industry and region seems to enhance the total factor productivity of domestic firms. Moreover, the size of these FDI spillover effects seems to depend both on the nationality of the foreign MNF as well as on the absorptive capacity of the domestic firm, measured by its own R&D. It appears that this positive relationship between foreign presence and productivity cannot be explained as a consequence of reverse causality, i.e that FDI is attracted to highly productive regions and industries.

Keywords: Multinational firms; Productivity spillovers; Foreign direct investment
JEL classification: F23; O30

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1. Introduction

In the popular debate, inward foreign direct investment, FDI – in particular acquisition of domestic firms by foreign companies – is often seen as creating a number of problems in the host country, such as a loss of national control[1] or outsourcing of jobs in general and skilled jobs in particular. On the other hand, governments spend large amounts of money in the form of subsidies to foreign multinationals, MNFs, in order to attract greenfield investment. Even if the major motive for this is the expected positive effects on regional employment in the short run, another motive is no doubt that FDI is supposed to be an important channel for dispersion of technical and commercial know-how to local firms, increasing their productivity.

A crucial question for deciding national policies towards inward FDI should then be how large and frequent such spillover effects really are. The aim of this paper is to evaluate the effects of the presence of foreign owned firms, FOFs, on the productivity of domestic firms in the Swedish manufacturing industry in the 1990s.

There is a large and growing empirical literature assessing the role of knowledge spillovers from FDI to domestic firms (for a survey see Görg & Greenaway 2001). Whereas a part of this literature is concerned with the effects on the domestic industry in developing countries of FDI from developed countries (e.g. Kokko & al. (1996), Blomström & Sjöholm (1999)), a number of recent studies have evaluated FDI spillovers among developed countries. Earlier studies, usually made with industry cross section data for a given year, such as Caves (1974) for Australia and Globerman (1979) for Canada, Blomström & Persson (1983) for Mexico did find evidence of a positive effect of FDI on the productivity of domestic firms.

For a number of more recent studies, mostly based on panel analysis of firm data, the results are more mixed. Barrios & Strobl (2001) for Spain, and Girma & al. (2001), Girma & Wakelin (2001), and Girma (2002) for the UK, do not find evidence of general spillover effects of FDI, equal for all firms and industries. Some studies, such as Barry & al. (2001) for Ireland and Konings (2001) for a number of transition economies, even find a negative effect. In a Swedish study using industry data in combination with data for the largest Swedish MNFs, Braconier & al.

[1] This appears to be based on the assumption that domestic capitalists are somehow more sensitive to issues of national welfare.

(2001) found no evidence whatsoever for positive spillover effects neither of outward nor of inward FDI.

It seems that a general conclusion from many recent studies would be that the evidence for sizeable spillover effects from FDI is weak or non-existing (Görg & Greenaway 2001). However, there are exceptions. Keller & Yeaple (2003) found statistically significant and fairly large productivity spillovers from FDI in US manufacturing. Significant FDI spillovers were also found for the UK industry by Haskel & al. (2002).

This study uses a panel of firm data for Swedish manufacturing 1990-2000 to investigate the existence of spillover effects from inward FDI.

2. Productivity and FDI – a framework for analysis

The question we ask in this paper is whether the productivity of a domestically owned firm, other things equal, can be shown to be higher because of the presence of foreign owned firms, and to increase with the extent of such presence. The first issues to be considered is why we should expect this to happen and what we should mean by “presence”.

There are several reasons why we should expect the productivity of domestic firms to increase with the establishment (by take-over or greenfield investment) of a foreign owned firm. First, this could increase competition, driving low-performing firms out of business and forcing remaining domestic firms to improve their efficiency e.g. by outsourcing of inefficient activities or in general by decreasing X-inefficiency (Wang & Blomström 1998). Second, there may be increased knowledge diffusion through licensing from the foreign owned firms. One may argue that the well-known market failures associated with arms-length sales of knowledge may be larger for cross-border sales than if the seller is represented by a local FOF.

Third, the productivity effect may be caused by some kind of productivity spillover from FDI. The knowledge dispersed to domestic firms may concern product design, production techniques or organization of the production process, but also knowhow used in marketing or exporting. The transfer of knowledge may occur by local management copying the MNFs way of organizing production or marketing, or by copying the product, or via exchange of labor, ex-employees of the MNF bringing their superior knowledge with them when switching jobs, to the benefit of local firms.

The issue of FDI spillovers has been addressed e.g. by Haskel & al (2002) and Keller & Yeaple (2003) by estimating a production function

$$Y_{it} = f(X_{it-\tau}, Z_{it-\tau}, P_{it-\tau}) \ , \qquad (1)$$

where $Y_{it}, X_{it-\tau}, Z_{it-\tau}, P_{it-\tau}$ are respectively production, a vector of factor inputs, a vector of variables affecting productivity, and the presence of foreign owned firms, for the *i*th firm. τ represents the lag structure for the independent variables (not necessarily the same). Equation (1) is then estimated on a panel of firm data. However, the most common approach in the literature (cf Görg & Greenaway 2001) seems to be to calculate a measure of total factor productivity for each domestic firm and year and regress that on the presence of foreign owned firms, together with a set of firm and industry control variables assumed to influence productivity:

$$A_{it} = \varphi(Z_{it-\tau}, P_{it-\tau}) \ . \qquad (2)$$

This is the method followed in this paper. We calculate the growth of TFP of the *i*th firm year *t* as the difference between the growth of output and a weighted index of the growth rates of the inputs, according to the equation

$$\begin{aligned} d\ln A_{it} &= d\ln Y_{it} - \omega_S d\ln S_{it-\tau} - \omega_U d\ln U_{it-\tau} - \omega_M d\ln M_{it-\tau} - \\ &- \omega_B d\ln B_{it-\tau} - \omega_I d\ln I_{it-\tau} \end{aligned} \ , \qquad (3)$$

where $Y_{it}, U_{it}, S_{it}, M_{it}, B_{it}, I_{it}$ are deflated sales, employment of unskilled and skilled workers, the deflated capital stock separated into machinery and buildings, and inputs of raw materials, energy and semi-processed goods, and the ω's are the Törnqvist weights calculated by relative cost shares.[2]

3. Productivity and the stock of knowledge

We assume a firm production function

$$Y_{it} = A_{it} F(X_{it-\tau}) \ , \qquad (4)$$

where A_{it} is a Hicks neutral efficiency parameter measuring total factor productivity. A_{it} of the *i*th firm in period *t* is assumed to be proportional to

[2] See Appendix for a more detailed description and motivation of the calculations.

the stock of firm specific knowledge. Such knowledge may come from different sources internal or external to the firm, such as R&D expenditure of the firm itself, learning by doing or knowledge spillovers from various sources, domestic or international, which may follow input-output or trade links. One particular link for spillovers may go from foreign owned firms to domestic firms in the host country. Let us write productivity as a function of the different components of the knowledge capital stock:

$$A_{it} = F(\kappa_{it}^{L}, \kappa_{it}^{R\&D}, \kappa_{it}^{S}, \kappa_{it}^{FDI}) \ . \qquad (5)$$

On the amount of knowledge coming from learning (κ_{it}^{L}) and spillovers in general, domestic and international (κ_{it}^{S}), we have no information, and thus we have to assume that these components of knowledge are the same for all firms. To start with we assume that the part of the knowledge stock acquired from FDI spillovers, κ_{it}^{FDI}, is a simple function only of the presence of foreign owned firms:

$$\kappa_{it}^{FDI} = \rho(P_{it-\tau}) \ . \qquad (6)$$

On the measurement of $\kappa_{it}^{R\&D}$, the firm specific knowledge stock generated by its own R&D activity, the ideal approach would be to calculate knowledge stocks by cumulating R&D expenditure over time, with deduction for depreciation, i.e. knowledge becoming obsolete (see Hall & Mairesse 1995). However, available time series were too short for that. Thus we have to use the *flow* of R&D expenditure as a proxy for the *stock* of firm specific knowledge.

Whether one should use R&D intensities (i.e. R&D as a proportion of sales or value added) or absolute R&D expenditures is open to discussion. The latter corresponds to the theoretical case where each firm, whatever its size, produces one single product, and a given amount of R&D expenditure results in a given improvement of the quality of that product or the efficiency with which it is produced, irrespective of the size of the firm, that is, R&D is a fixed cost. For the multi-product case, where the size of firms is proportional to the number of products, the R&D intensity should be the relevant measure provided that there are no economies of scope in the R&D activity.

4. On the definition and measurement of the presence of foreign owned firms

It seems natural to think of the potential for FDI spillovers to be larger the closer – in some sense – the FOF is to the domestic firm. “Closeness” may have both an industry and a spatial or regional dimension. It may seem obvious that this potential should be larger between a foreign owned and a domestic firm involved in the same activities, i.e. in the same industry. However, knowledge spillovers might also follow input-output flows, both upstream – from a foreign owned customer to a domestic seller – and downstream.[3] Moreover, it is not clear which definition of “industry” – i.e. which level of aggregation – is the proper one. Keller & Yeaple (2003) argue that the FDI presence should be calculated on a very detailed within-firm activity level.

Equally obvious, there must be some spatial dimension to such knowledge spillovers, that is, spillovers are reduced by geographical distance. This may be true when the domestic firm learns by observing and copying, as well as when the knowledge enters through labor turnover, since labor mobility should be higher within local labor markets than on the national level. If there were no spatial dimension to spillovers at all, one might ask why the existence of FOFs should be important, since in that case spillovers could “travel” equally well from the parent MNF abroad. Again, it is not evident which level of regional aggregation is appropriate.

The presence of foreign owned firms *P* may be measured as FOFs share of total employment, production or capital stock, where most studies seem to prefer the employment variable. Thus the productivity of a domestic firm *i* in the *j*th industry in the *r*th region may be affected by the share of employment of foreign owned firms (top index *F*) in that region and industry[4]:

$$P_{jrt} = \frac{\sum_{i=1}^{n} L_{ijrt}^{F}}{\sum_{i=1}^{N} L_{ijrt}} \quad . \tag{7}$$

[3] On the issue of knowledge spillovers following input-output flows see e.g. Griliches (1992) and (1995).

[4] Clearly the relationship between FOF presence and knowledge stock in eq. (6) may be non-linear. Castellani and Zanfei (2002) use employment in foreign owned firms rather than their employment share to measure presence of FOFs, to reflect that it takes a certain minimum scale in order for spillovers to take place. If employment increases in both foreign and domestic owned firms at a similar rate, the employment share will be unchanged.

Haskel et al (2002) separates industry and regional presence by constructing two separate variables, allowing discrimination between the “activity” and “spatial” dimensions of “closeness” and their contributions to domestic firms´ TFP.

$$P_{rt} = \frac{\sum_{i=1}^{n} L_{irt}^{F}}{\sum_{i=1}^{N} L_{irt}} \ , \qquad P_{jt} = \frac{\sum_{i=1}^{n} L_{ijt}^{F}}{\sum_{i=1}^{N} L_{ijt}} \ . \tag{8}$$

This may be improved by allowing for differential effects of knowledge spillover according to the nationality of the parent company (Girma & Wakelin 2001, Haskel & al. 2002). This may be done by substituting for the two variables P_{rt}, P_{jt} a set of variables P_{rgt}, P_{jgt}, $g = 1,...,m$, where presence of FOF is measured taking account of the nationality g of the parent company.

The productivity effect of a given presence of foreign owned firms may differ with the performance of the domestic firm. Here there are two hypotheses. On the one hand, the potential for knowledge spillovers should be greater the larger the technology gap, i.e. the difference in efficiency and know-how, between the foreign firm and the domestic firm (Findlay 1978). On the other hand, the actual transfer of knowledge should require a certain level of absorptive capacity in the domestic firm to spillovers from FOFs (Cohen & Levinthal 1989). Grünfeld (2003) suggests proxying the capacity of a firm to absorb knowledge spillovers by the size of its own R&D expenditure. Another possible proxy could be the proportion of skilled labor in the total employment of the receiving firm (Girma & Wakelin 2001, Haskel & al. 2002).

There are several ways to address the issues of technology gap and absorptive capacity. Following Kokko & al. (1996) and Girma & Wakelin (2001) one may split up the sample according to the level of absorptive capacity of the firms included, measured by R&D, skilled labor or TFP itself, allowing for non-linear relationships between capacity/technology gap and spillovers (Girma 2002). Another method, which is used here, is to introduce an interaction variable equal to the product of the firm’s own R&D and the variable(s) measuring presence of FOFs. Alternatively one could use an indicator of human capital intensity such as the share of skilled workers – defined by level of education – instead of the R&D variable. This allows the effect of an increase in the presence of foreign ownership in the industry/region on domestic productivity to be dependent on the level of R&D or human capital in the domestic firm.

5. Data[5]

The data, supplied by Statistics Sweden, include all manufacturing firms in Sweden with at least 50 employees for the years 1990-2000. The data base contains data by firm on output (gross production and value added), employment, capital stock, purchases of other inputs, R&D expenditure etc.

Foreign ownership is defined in the statistics as the case where a foreign firm has a controlling position in a Swedish firm, which in turn is defined as possessing 50% or more of the votes (not necessarily equal to 50% of the shares, since Swedish firms may – and do – issue shares with widely different voting power). Obviously the issue of foreign control is not so simple that it can be completely described by a binary variable switching from 0 to 1 at a certain level of voting power, here 50%, since - depending on the ownership structure - a share of the votes much lower than that may be sufficient to give a high degree of control.

It should be noted that almost two out of three firms in our sample report zero R&D expenditure, which means that taking logarithms of the R&D variable – whether as intensity or in absolute terms – drastically reduces the sample size. In the estimations presented below the R&D variable is included without taking logarithms, in order to preserve the sample size.

The interpretation of the measure of regional presence of FOFs according to eq. (8) is complicated by the existence of large multi-plant firms which are registered by region by the location of the head-quarter, while the plants may be distributed all over the country; since we do not have access to plant data we cannot properly address this problem. A similar problem arises because of the existence of large conglomerate firms actually producing in a number of industries, while the firm is allocated to an industry based on the main type of production; this problem has been pointed out by Keller & Yeaple (2003).

6. Estimation

Our basic approach is to estimate the following equation:

$$\ln A_{ijrt}^{d} = \beta_0 + \beta_1 P_{rt-\tau} + \beta_2 P_{jt-\tau} + \beta_3 R_{it-\tau}^{D} + \beta_4 \ln \sigma_{it} + \varepsilon_{it} \ , \qquad (9)$$

[5] A more thorough description of the variables as well as information on the panel survival rates and the distribution of foreign employment by industry and region are given in the appendix.

where $A^d_{ijrt}, R^D_{it-\tau}, \sigma_{it}$ are TFP, R&D expenditure[6] and the size of domestic firm *i* in the *j*th industry and *r*th region in period *t*, with the appropriate time lag, and $P_{rt-\tau}, P_{jt-\tau}$ foreign presence in that region and industry, measured by the share of employment in FOFs as in eq. (8). In the regressions we have included the variable relative firm size, measured as employment of the *i*th firm relative to average employment per firm in the industry:

$$\sigma_{it} = \frac{L_{it}}{n_j^{-1}\sum L_{it}} \quad , \qquad (10)$$

where n_j is the number of firms in the *j*th industry, to reflect economies of scale in production of the final good but also in production of knowledge from R&D.

Haskel & al. (2002) argue in favour of using first differences, alternatively fixed effects panel estimation, to address the problem of unobserved firm specific level effects. This is likely to be a serious problem since we cannot hope to capture all of the productivity differences among firms by the control variables for which we have data. Basically we use the fixed effects approach. As a check we have also estimated eq. (9) by pooled OLS on first differences. To verify the robustness of our main results, we have estimated the specifications reported in the tables, using an unbalanced panel, also with a balanced panel. The balanced panel consists of about half as many firms as the unbalanced panel. The results are very similar.

In principle, the dynamics of adjustment of the TFP of a firm to changes in its R&D and in the presence of FOFs are likely to be complicated. Since our time series are so short we make no serious attempt to explore the dynamics of the model in detail. The P values are strongly correlated over time. In the estimations we simply let the data decide on the lag length, picking the lag that appears to have the strongest effect. Mostly we set $\tau = 1$, that is, we use one period lagged values of all the right hand side variables except P_j, the presence of foreign firms in the industry, where the lags involved seem to be longer, and σ without lags. As to functional form we have used a log-linear equation when all variables except fractions and the R&D variables (to preserve sample size) are in logarithms.

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[6] As an alternative to the research expenditure we use r^d_{it}, the R&D intensity of the *i*th firm, defined as the ratio of R&D expenditure to sales.

The knowledge spillover from a given foreign owned firm may not be constant over time but depends on the time of acquisition. To account for this we calculate two sets of variables for regional and industry presence, the first based on the share of employment in foreign firms acquired before, and the second firms acquired within, the period 1990-2000.

The actual flow of knowledge spillovers from FDI may depend on the characteristics of the domestic firms. The potential for spillovers may increase with the technology gap between the two firms, while obstacles to such spillovers are reduced by the level of absorptive capacity of the domestic firm, which may have to do with the level of technological and commercial sophistication of that firm. To explore these issues we introduce two interaction variables, calculated as the product of the presence variables (in the region and industry) and the R&D activity of the domestic firm. In addition, we split the sample of Swedish owned firms into two groups: Swedish multinationals[7] and Swedish owned local firms. We may assume that the technology gap is higher for the local firms, but on the other hand their absorptive capacity may be lower.

Finally there might be problems with causal interpretation and endogeneity bias if foreign MNFs tend to invest in particular regions and industries with higher than average productivity. To control for this we have tested for endogeneity by regressing the variables measuring FOF presence, i.e. P_{rt}, P_{jt}, on region and industry specific variables. If endogeneity cannot be rejected we present the corresponding instrumental variables regressions.

7. Does presence of foreign owned firms enhance productivity of domestic firms?

Table 1 show the results of fixed effects estimations of eq. (9), using a panel of domestically owned Swedish manufacturing firms with at least 50 employees for 1990-2000. As an indicator of the knowledge stock produced by the firm itself we have used alternatively the R&D expenditure or the R&D intensity (in per cent of sales). Since a large

[7] Since we cannot pick out multinational firms in our data set we have separated this group of firms on the basis of the distribution of total sales. If a firm reports any export to foreign affiliates the firm is counted as a multinational. This leaves among the local firms such firms that are multinational, in the sense of having producing affiliates abroad, but for some reason have no exports to these.

number of firms report zero R&D activity we do not take logarithms of that variable, in order to preserve the sample size.

According to table 1, the R&D activity of a domestically owned firm seems to be an important determinant of its total factor productivity. The coefficient of the R&D variable is positive and strongly significant. However, this holds only when R&D is measured as expenditure in absolute terms, while the R&D intensity (not in table) is not significant.

As shown in Table 1, the presence of foreign owned firms, both in the region and in the industry, seems to enhance the productivity performance of domestic firms. The variables measuring regional as well as industry presence are positive and strongly significant in both specifications. It appears that foreign presence in the industry takes longer time to produce an effect on domestic firm's productivity than presence in the region, since shorter lag lengths give insignificant results. This may be because the spillover of such knowledge that typically takes place among firms in the same industry, such as product design and production methods, takes longer time than spillovers of knowledge that is not industry specific, such as general management and marketing skills.

Here the presence of FOFs, defined as the share of employment of FOFs in total employment in the region and industry, have been measured on a rather low level of aggregation, that is, local municipality and 2 digit SNI. Varying the level of aggregation - 2 to 5 digit SNI, counties (län), labor market areas (A-regioner) or municipalities (kommuner) – gives similar results, though the significance of individual variables may differ somewhat.

The difference between columns 1 and 2 in table 1 is that the latter includes a time dummy variable while the former does not. This variable is expected to pick up a common – to all firms – time pattern in TFP, presumably related to economy-wide variations in the degree of utilization of labor and capital over the business cycle. Controlling for this in column 2 reduces the estimated effects of presence of foreign firms, though the P_j, P_r variables are still strongly significant.

It appears that the TFP of domestic firms is positively related to relative firm size in column 1 but negatively in column 2. In fixed effects estimation, where the firm specific level effects are eliminated, this variable is likely to capture the effects of firm specific variations in capacity utilization connected with expansion or contraction of production and the labor force, rather than economies of scale. The varying results make the interpretation of this variable difficult.

Table 1 Effects of presence of foreign owned firms on productivity performance of domestically owned firms in Swedish manufacturing 1990-2000

Dependent variable: TFP in domestic firms $\ln A_{it}^D$	FE	FE
foreign ownership in industry P_{jt-3}	0.0189 (19.80) ***	0.0033 (5.55) ***
foreign ownership in region P_{rt-1}	0.0060 (11.18) ***	0.00076 (2.36) **
R&D expenditure R_{it-1}	1.06E-7 (5.29) ***	5.61E-8 (5.13) ***
relative firm size $\ln(\sigma_{it})$	0.223 (10.25) ***	-0.026 (-2.00) **
constant	1.29	2.42
time dummy	No	Yes ***
F	171 ***	1217 ***
F all u(i)=0	11.35 ***	28.56 ***
Hausman χ^2		170.28 ***
$\bar{R}^2$		
- within firm	0.1027	0.6910
- between firms	0.0005	0.1662
- total	0.0020	0.2509
number of observations	7630	7630

Note. TFP and firm size in logarithms. ***, **, * significant on the 1%, 5% and 10% level. For definition, measurement and sources of the variables see text. FE fixed effects panel estimation. Hausman χ^2 test for endogeneity of the P_{rt-1} variable.

In order to deal with the problem of omitted variables, as a complement to the fixed effects panel estimates in table 1, and also with possible autocorrelation, we have estimated eq. (9) on first differences.[8] To capture the effects of general inter-firm, intra-industry spillovers (i.e. not just from foreign owned firms), we include in the equation the initial TFP level of the firm. A negative sign of the estimated coefficient for this variable implies a tendency to convergence of productivity levels among firms, i.e. that productivity growth tends to be higher for firms with a low initial productivity. This could be an effect of knowledge spillovers from the more productive to the less productive domestic firms.

[8] Using fixed effect estimation on panel data is efficient under the assumption that heteroskedasticity and serial correlation is not a big issue. An alternative to a panel data estimator is the pooled OLS estimator on time differenced variables. The precision is higher in these estimates, given that the assumption of heteroskedasticity and serial correlation is correct.

Table 2 Effects of changes in the presence of foreign owned firms on productivity growth in domestically owned firms in Swedish manufacturing, 1990-2000

Dependent variable $d \ln A_{it}^D$	OLS
initial TFP level $\ln A_{it-1}^D$	-0.183 (-10.16) ***
change of foreign ownership in industry dP_{jt-1}	0.390E-3 (2.24) **
change of foreign ownership in region dP_{rt-1}	0.384E-3 (2.48) **
change of R&D expenditure dR_{it}	4.08E-8 (5.11) ***
relative firm size $\ln \sigma_{it}$	0.431E-3 (0.17)
time dummy	yes ***
$\bar{R}^2$	0.336
number of obs.	9110

Note. OLS estimates with Prais-Winsten panel corrected standard errors. The variable P_j, presence of foreign owned firms in the industry, is calculated on the 3 digit level of SNI.

8. Extensions: the role of the nationality of the parent MNF and absorptive capacity

Up to this point we have dealt with the issue of FDI spillovers among two homogenous groups of firms, namely foreign owned and domestic. It is, however, possible that knowledge spillovers and their effects on productivity may be different depending on the characteristics of the foreign firm – the nationality of the MNF, or the length of time since the firm was acquired or set up – as well as of the receiving domestic firm.

First, we eliminated Swedish multinational firms from the sample (see section 6) and re-estimated the equations in table 1 but now only for Swedish owned non-multinationals, here called local firms. One might expect the effect of the presence of foreign owned firms to be larger on local firms than for the sample of all domestic firms, on the ground that the technology gap between sender and receiver would be larger. However, the results (not shown) contradict this hypothesis; the spillover effects, if anything, seems to be weaker and less significant for the local firms. This may have to do with a low level of absorptive capacity in local firms compared to Swedish multinationals; we will come back to this point.

Next, we divided the group of foreign owned firms into two with respect to the date of acquisition or establishment. “New” foreign owned firms were acquired in 1990-2000, and “old” foreign owned firms before 1990. Then we ran the same regression as in table 1. Table 3 confirms the results in table 1: the presence of foreign owned firms indeed enhances the productivity of domestic firms. However, it seems as if it is only the presence of foreign owned firms acquired in 1990-2000 that matters; presence of “old” foreign owned firms (acquired before 1990), apparently has no productivity effects, neither in the industry nor in the region.

Up to now, we computed foreign presence – in the region and industry – without taking the nationality of the MNFs into account. Now we substitute a set of variables

$$P_{gjt} = \frac{\sum L_{ijt}^{g}}{\sum L_{ijt}} \, , \qquad g = 1,...,m. \qquad (11)$$

measuring the share of employment in the *j*th industry accounted for by Swedish firms owned by a company from country *g*, for the P_{jt} variable used in table 1. We have calculated P_{gjt} separately for different country groups. We concentrate here on foreign presence in the industry.

Our results indicate that the nationality of the parent company matters for the effects on domestic firms´ TFP of foreign presence in the industry (here by 2 digit SNI). In the regression in table 4 it would seem that US firms have a stronger positive effect on productivity in Swedish owned firms than FDI from the rest of the world. This may be due to a larger stock of firm specific knowledge that could be dispersed to local firms, or to an inability to prevent spillovers. A more detailed subdivision (not in table) indicates that Japanese investment may have a still stronger effect on the performance of domestic firms. However, this result is based on a rather small number of Japanese owned firms in the sample. To some extent the exact ranking in this case seems to depend on the exact specification of the regression equation.

Table 3 Effects of presence of foreign owned firm, separated by year of acquisition, on productivity performance of domestically owned firms in Swedish manufacturing 1990-2000

Dependent variable $\ln A_{it}^{D}$	FE
foreign ownership in industry; firms acquired before 1990 P_{jt-3}^{O}	-0.87E-3 (-0.75)
foreign ownership in region; firms acquired before 1990 P_{rt-1}^{O}	0.34E-3 (0.78)
foreign ownership in industry; firms acquired after 1990 P_{jt-3}^{N}	6.45E-3 (7.40) ***
foreign ownership in region; firms acquired after 1990 P_{rt-1}^{N}	1.44E-3 (2.96) ***
R&D expenditure R_{it-1}	5.66E-8 (5.18) ***
log (relative firm size)	-0.030 (-2.25) **
constant	2.48
year	yes ***
F	182***
F all u(i)=0	11.4***
$\bar{R}^2$	
- within firm	0.692
- between firms	0.176
- total	0.259
number of observations	7630

Note. The first group – firms acquired before 1990 – includes also a small group of firms shifting ownership more than once.

Table 4. Effects of presence of foreign owned firm, separated by nationality of MNF, on productivity performance of domestically owned firms in Swedish manufacturing 1990-2000

Dependent variable log(TFP)	FE
foreign ownership in industry - US firms P_{jt-3}^{US}	0.767E-2 (5.57) ***
- firms from rest of the world P_{jt-3}^{RoW}	0.240E-2 (3.64) ***
foreign ownership in region P_{rt-1}	0.074E-2 (2.29) **
FoU- utgifter R_{it-1}	5.57E-8 (5.10) ***
relative firm size $\ln \sigma_{it}$	-0.024 (-1.80) *
time dummy	Yes ***
constant	2.41
F	119 ***
F all u(i)=0	28.6 ***
$\bar{R}^2$	
- within	0.691
- between	0.166
- total	0.250
number of obs.	7633

Note: Foreign ownership in US firms is defined as the employment in the *j*th industry accounted for by US firms, relative to the total employment in the same industry.

Table 5 shows the results of estimating equations where we add two interaction variables

$$B_{it} = P_{jt} R_{it}^{D} \quad \text{and} \quad C_{it} = P_{rt} R_{it}^{D}. \qquad (12)$$

to equation (9), where $P_{jt}, P_{rt}, R_{it}^{D}$ is presence in industry and region of FOFs and R&D expenditure in the *i*th domestic firm. These variables are intended to capture the possible role of the absorptive capacity of a domestic firm in the host country, measured by its R&D activity, for the effect on its TFP of the presence of foreign ownership in the industry or the region.

Table 5 The role of absorptive capacity for the effects of presence of foreign owned firms on productivity of domestic firms in Swedish manufacturing 1990-2000.

Dependent variable $\ln A_{it}^{D}$	FE
foreign firms in industry P_{jt-3}	0.003 (5.12) ***
foreign firms in region P_{rt-1}	0.0007 (2.17) **
R&D expenditure R_{it-1}	-0.221E-08 (-3.55) ***
firm size $\ln(\sigma_{it})$	-0.026 (-2.00) **
[FDI in industry]*[R&D] $P_{jt-3}R_{it-1}$	0.67E-10 (5.17) ***
[FDI in region]*[R&D] $P_{rt-1}R_{it-1}$	0.970E-10 (4.05) ***
constant	2.42
year	Yes
F	1036.37 ***
F all u(i)=0	28.56 ***
$\bar{R}^2$	
- within firm	0.6921
- between firms	0.1701
- total	0.2552
number of observations	7630

Table 5 supports the hypothesis that the size of the productivity effects on domestic firms from the presence of foreign owned firms does not only depend on the importance in the industry and/or region of such firms, but also on the absorptive capacity in the domestic firms. The level of its own R&D expenditure, supposed to reflect the level of technical or commercial sophistication, seems to enhance the capacity of a domestic firm to absorb knowledge spillovers from their foreign owned competitors. An alternative measure of absorptive capacity, the stock of human capital per worker, measured by the proportion of the labor force with post-secondary education, gives similar but somewhat less clear-cut results. Thus we find evidence for the absorptive capacity hypothesis but not for the hypothesis that the size of the actual technology transfers is a positive function of the technology gap.

9. Do foreign MNFs invest in highly productive regions and industries?

So far we have treated the *P* variables – the presence of foreign owned firms in the industry and region – as exogenous. However, the FDI decision is likely to be the outcome of a process where economic variables are involved. In particular it may be the case that foreign MNFs are attracted to regions and/or industries where firms on average happen to be more productive. The existence of such two-way causality may lead to erroneous conclusions about the spillover effects of FDI.

The industry pattern of inward FDI is likely to be influenced, first, by factors shaping the comparative advantage of the Swedish economy, and second, by characteristics related to the presence and importance of various firm specific advantages of MNFs in an industry, such as better products, more efficient production techniques or better marketing methods, which could be utilized by production in different locations. Previous studies of trade patterns (e.g. Hansson & Lundberg 1995) show that the Swedish economy seems to have a comparative advantage in skill intensive and possibly also capital intensive production, but not in R&D intensive industries per se (Lundberg 1988).

Studies of the industry pattern of inward Swedish FDI (Modén 1998, Gustavsson & Kokko 2003) indicate that this pattern resembles the industry structure of net exports in the sense that the shares of employment and production of foreign owned firms in the industry is especially high in skill intensive sectors (Gustavsson & Kokko 2003). In the 1970s, inward Swedish FDI was concentrated to the chemical industry (Samuelsson 1977). In the late 1990s, a dominant part of employment and production in petroleum refineries and the pharmaceutical industry was accounted for by foreign owned firms, while foreign ownership is much less frequent in textiles and industries for wood and metal products.

With regard to the regional pattern of inward FDI there is less information. If it is true that foreign MNFs exploit the comparative advantage of the Swedish economy by concentrating in skill intensive industries, the same may hold with respect to the regional pattern. Moreover, it is possible that FDI is attracted by agglomeration economies to large and/or densely populated regions with a large labor markets.[9]

[9] Since foreign presence in industry is already lagged three periods, we initially assume that potential reverse causality between productivity in domestic firms and the foreign presence in the industry three years earlier is small.

The instruments created for foreign presence in region is the product of regressing foreign presence in region on the skill intensity and capital intensity of the region[10], plus the other variables assumed exogenous, namely FORj, R&D and firm size. The measurement of these variables is described in the Appendix. Then we estimated equation (9) using instrumental variables fixed effects panel regression where the estimated instruments $\tilde{P}_{rt}$ are substituted for the actual variables measuring FOF presence in region. A Hausman test indicates that the *P* variables must indeed be treated as endogenous in the sense that they are correlated with the error term in the equation, which may give rise to simultaneity bias in the estimated coefficients.

In table 6 column 1 we instrument for the presence of foreign firms in the region (P_r), by using skill and capital intensities in the region. The coefficients don't alter much as compared to table 1 column 2 except for the increase in estimated magnitude of foreign ownership in region, but the LR test rejects the joint hypothesis that the overidentifying restrictions are valid (the instrumental variables is described in the Appendix). [11] In column 2 and 3 the specifications fulfils the overidentifying requirements. We again instrument P_r but this time by using skill intensity and the share of domestic multinationals in the region, the size of the region (population) and the export intensity in the region, as instruments. The coefficient and the corresponding z-values don't alter much. In column 3 only P_j is instrumented for by using the share of domestic multinationals in the industry and the export intensity in the industry (both defined at the two digit SNI). Again the picture is similar to that in table 1 column 2. The results in table 6 show that the presence of foreign owned firms in the industry and region does enhance the total factor productivity of domestic firms in Swedish manufacturing, even when we have taken the two-way relationship between presence and productivity into account. Thus our main result still hold: inward FDI increases the productivity of local firms in the host country.

[10] The agglomeration effect, proxied by the size of the labor market and measured as the number of employees in manufacturing in the region, was insignificant and therefore left out.

[11] If the number of instruments exceeds the number of endogenous variables it's necessary to test the validity of the instruments. Davidson and MacKinnon (1993) developed a test of the joint hypothesis that the overidentification restrictions are valid, i.e. the instruments are uncorrelated with the error term. The LR test used reports test statistic, degrees of freedom and P-values.

Table 6. Effects of presence of foreign owned firms on the productivity performance of domestically owned firms in Swedish manufacturing 1990-2000, controlling for determinants of foreign ownership

Dependent variable $\ln A_{it}^{D}$	1 2SLS FORr instrumented	2 2SLS FORr instrumented	3 2SLS FORj instrumented
foreign firms in industry P_{jt-3}	0.003 (5.10) ***	0.004 (5.55) ***	0.006 (1.93) ***
foreign firms in region P_{rt-1}	0.006 (2.93) ***	0.003 (1.78) *	0.0007 (2.27) **
R&D expenditure R_{it-1}	5.54E-08 (4.97) ***	5.64E-08 (5.17) ***	5.69E-08 (5.18) ***
firm size $\ln(\sigma_{it})$	-0.025 (-1.87) **	-0.038 (-2.80) **	-0.020 (-1.37)
constant	32.46	31.90	26.83
year	Yes ***	Yes ***	Yes ***
F			
F all u(i)=0	27.48	27.78	28.44
Overidentification	187.538 ***	5.48	2.022
$\bar{R}^2$			
- within firm	0.6781	0.6913	0.6897
- between firms	0.1526	0.1637	0.1539
- total	0.2414	0.2494	0.2420
number of observations	7630	7215	7630

Note! In column 1 only P_{rt-1} is instrumented for, by using skill and capital intensities in the region. In column two (again) only P_{rt-1} is instrumented for but now by using skill intensity and the share of domestic multinationals in the region, the size of the region (population) and the export intensity in the region. In column three only P_{jt-3} is instrumented for by using the share of domestic multinationals in the industry and the export intensity in the industry (both defined at the two digit SNI). The specification in column 1 is overidentified, but not the specifications used in column 2 and 3.

10. Conclusions

Foreign direct investment FDI is widely believed to play an important role for international transmission of new technology, stimulating productivity and economic growth in the host country. The question is, however, if it is possible to prove empirically the existence of such spillover effects.

This paper analyzes the evidence for inward FDI spillovers in Swedish manufacturing. Using a data base covering all manufacturing firms with at least 50 employees in the period 1990-2000, we regress a measure of total factor productivity of domestic firms on two variables measuring the presence of foreign owned firms in the same industry and region, defined as foreign firms´ share of employment, together with other control variables assumed to affect productivity, such as firms´ own R&D activity. To minimize the problem with unobserved variables we use fixed effects panel estimation or alternatively first differences.

The results provide strong evidence for the existence of spillover effects from inward FDI to domestic firms. Both industry and regional presence of foreign owned firms seem to enhance productivity in domestic firms. The results are strongly significant and robust with respect to measurement of variables and estimation methods.

Moreover, the productivity effects of a given amount of FDI seem to depend both on the nationality of the parent MNF, as well as on the absorptive capacity of the receiving firm, measured by its own R&D. Of the two conflicting hypotheses – that the potential for spillovers are increasing with the technology gap between the foreign and the domestic firm, but that the actual transmission of knowledge is facilitated by a high technology level of the receiving firm – we find support for the second but not for the first. There is also clear evidence that the main part of FDI spillovers originates from the presence of comparatively recent foreign acquisitions of greenfield investment. Finally, we find evidence supportive for the assumption of reverse causality, i.e. foreign MNFs could be attracted to regions and/or industries where firms on average happen to be more productive. To circumvent the problems associated with reverse causality we use a 2SLS approach. The results from the 2SLS estimates give support for positive effects of foreign presence on the productivity of domestic firms.

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12. Appendix

TABLE A1. DESCRIPTION OF VARIABLES[12]

Variable name	Description
Capital intensity	Deflated book value stock of capital over total employment.
Skill intensity	The percentage share of employe's with a post secondary education
R&D	R&D expenditure in SEK, from the Financial Statistics.
Firm size	Measured as employment of the *i*th firm relative to average employment per firm in the industry
FORr	Employment in a foreign-owned plant as a share of total employment in the region. There are 290 municipalities in Sweden.
Instruments for FORr	1. Yearly share of employment in Swedish multinationals in region *r*[13]. 2. Yearly export intensity (export/total sales) in the region *r*. 3. Yearly skill intensity in region *r* 4. Yearly region size (dummy variable; 1 if population > 100 000, 0 else)
FORj	Employment in a foreign-owned plant as a share of total employment in the industry. Industry is defined at either the two, or three-digit level.
Instruments for FORj (two digit industry)	1. Yearly share of Swedish multinationals in industry *j* 2. Yearly export intensity (export/total sales) in industry *j*
Industry dummy	Defined at either two, three, four or five digit SNI92.
Region dummy	There is 290 local municipalities (kommuner), 70 labor market areas A-regions (A-regioner) and 21 counties (län) in Sweden. The regional dummy we use is defined as local municipalities (kommuner).
Time dummy	Yearly time dummies
Foreign ownership	A dummy variable (0,1). 1 if firm *i* is a foreign owned firm and 0 otherwise. Foreign ownership is defined here as the case where a foreign firm has a controlling position in a Swedish firm, which in turn is defined as possessing 50% or more of the votes (not necessarily equal to 50% of the shares, since Swedish firms may – and do – issue shares with widely. different voting power)

[12] Source: Statistics Sweden

[13] If a firm reports any export to a foreign affiliate we consider it a Swedish multinational.

TABLE A2 THE YEARLY DISTRIBUTION OF FOF 1990-2000 [14]

Year	All firms	Number of FOF[15]	Years of Panel survival	Number of FOF
1990	2020	346	1	182
1991	1943	367	2	160
1992	1761	363	3	129
1993	1612	320	4	89
1994	1656	339	5	50
1995	1754	408	6	73
1996	1804	416	7	63
1997	1845	446	8	38
1998	1928	486	9	28
1999	1892	493	10	35
2000	1938	528	11	112

TABLE A3 PERCENTAGE SHARE OF FOREIGN EMPLOYMENT, BY INDUSTRY

Two digit industry	1990	2000
15 Food and drink manufacturing industries	19.5	30.0
16 Tobacco manufacturing industries	0	49.8
17 Textile industry	14.8	23.6
18 Manufacture of wearing apparel leather	1.1	13.9
19 Manufacture of leather goods	2.1	3.3
20 Manufacture of wood and wood products	5.3	13.6
21 Manufacture of pulp, paper, and paper products	14.7	34.0
22 Publishing, printing, and reproduction of recorded media	4.2	10.2
23 Manufacture of chemicals	20.6	82.0
24 Manufacture of petroleum products	27.6	74.6
25 Manufacture of Rubber and plastic products	24.4	23.4
26 Manufacture of non-metallic mineral products	32.1	50.2
27 Manufacture of basic metalls	8.8	27.1
28 Manufacture of fabricated metal products, except machinery and equipment	13.8	9.9
29 Manufacture of machinery and equipment	26.1	33.3
30 Manufacture of office machinery and computers	38.3	20.4
31 Electrical machinery	42.8	30.1
32 Electronic engineering	27.8	17.4
33 Optical products	23.6	32.1
34 Manufacture of motor vehicles	6.2	50.6
35 Other transport equipments	6.6	22.5
36 Other manufacturing industries	12.7	10.1
Total manufacturing industry SNI92: 2 digit 15-36	16.9	27.5

Note! Source: Statistics Sweden. The data covers all manufacturing firms with at least 20 employees.

[14] Foreign Owned Firms (FOF).

[15] From the first two columns in the table A2 we see e.g. that in 1990 there is in total 2020 firms (with at least 50 employee's), and out of these there is 346 FOFs in the panel. From the other two columns we see that there is 182 FOF's that only participate one year in the panel, 160 firms that survive 2 years etc.

TABLE A4 PERCENTAGE SHARE OF FOREIGN EMPLOYMENT, BY REGION

	Counties	1990	2000
1	Stockholms län	16.9	28.5
3	Uppsala län	21.0	7.1
4	Södermanlands län	25.2	21.4
5	Östergötlands län	30.7	28.6
6	Jönköpings län	10.4	16.8
7	Kronobergs län	10.5	15.7
8	Kalmar län	19.5	25.2
9	Gotlands län	0	3.0
10	Blekinge län	13.7	54.9
12	Skåne län	20.4	31.5
13	Hallands län	16.7	20.8
14	Västra Götalands län	18.1	31.9
17	Värmlands län	19.6	37.8
18	Örebro län	18.6	27.9
19	Västmanlands län	43.2	34.6
20	Dalarnas län	6.5	36.7
21	Gävleborgs län	10.3	12.6
22	Västernorrlands län	19.5	23.7
23	Jämtlands län	8.2	0.4
24	Västerbottens län	12.1	9.8
25	Norrbottens län	5.4	2.6

Note! Source Statistics Sweden. The data covers all manufacturing firms with at least 20 employees.

Total factor productivity

In the calculation of TFP we assume that deflated sales *Y* is produced using five factors of production; capital *K* (disaggregated into rental cost of building *B* and rental cost of machinery *M*), Labor (disaggregated into skilled labor *S* and unskilled labor *U*) and intermediate goods *I* (raw materials, energy and semi-processed goods). [16]

The general production function:

$$Y_{it} = A_{it} F(S_{it}, U_{it}, M_{it}, B_{it}, I_{it})$$

where A_{it} is a Hicks neutral efficiency parameter measuring total factor productivity. For each firm we calculate TFP as the ratio of deflated sales to an index of input volumes. Since we lack continues-time data we use Törnqvist quantity index of inputs. This index is a discrete-time approximation to continues-time models. Diewert (1976) showed that the

[16] The input and output are book values from the financial statistics and are deflated by the appropriate four-digit (or alternatively three-digit) industry price deflator.

Törnqvist index was not an approximation but an exact index number under the right conditions.[17]

$$\ln TFP_{it} = \ln Y_{it} - \ln X_{it}$$

The Törnqvist input quantity index, X_{it} is defined as

$$\ln X_t = \sum_{i=1}^{n} \varpi_{i,t} \ln X_{it}$$

where the weights is defined as average cost shares according to[18]

$$\varpi_{it} = \frac{1}{2}\left(\frac{P_{i,t-1} X_{i,t-1}}{\sum_{K=1}^{n} P_{k,t-1} X_{k,t-1}} + \frac{P_{i,t} X_{i,t}}{\sum_{K=1}^{n} P_{k,t} X_{k,t}} \right)$$

where P_i is the input price of input *i*. We calculate rental price for capital separately for machinery and buildings, see e.g. Gunnarsson & Mellander (1999), Harper Berndt & Wood (1989).

$$P_{K,t} = P_{I,t}\left[r_{t-1} + \overline{\delta}_K + (\overline{\delta}_K - 1) * \frac{P_{I,t-1} - P_{I,t-2}}{P_{I,t-2}} \right]$$

where $P_{K,t}$ denotes the rental price of machinery and buildings respectively. $P_{I,t}$ is the price index for either capital or machinery, r_{it} is the long term interest rate and $\overline{\delta}_K$ is the average rate of depreciation.

[17] The Törnqvist (1936) index is based on a general (flexible) Cobb Douglas production function (Translog). See e.g. Harper, Berndt & Wood (1989) or Gunnarsson and Mellander (1999).

[18] The index outlined in Törnqvist (1936) fulfils important properties such as invariance and independence, se e.g. Diewert (1976, 1978).

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