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Regional productivity effects of multinational firm affiliates

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Abstract: Multinational firms (MNFs) have been shown to have a set of defining characteristics. Compared to domestic firms, they have a larger fraction of skilled workers, higher R&D to sales ratios and established networks to knowledge sources in several different countries. As illustrated by the so-called 'anchor-tenant' hypothesis, they can be described as "knowledge spillover agents". MNF affiliates, as defined in this paper, are firms that are part of large domestic and foreign MNFs. In this paper we test whether the local presence of MNF affiliates generate spillover effects on the local industry. The empirical analysis focuses on assessing whether the productivity of the regional manufacturing industry of non-affiliated firms is higher in regions with a large fraction of MNF affiliates. The analysis uses data on Swedish firms and is conducted on regional level as well as on firm level. The regressions show that local presence of MNFs in a region has a positive effect on Gross Regional Product (GRP) from non-MNFs. The paper also shows that regions where the low-productive non-MNFs are located appear to benefit the most from local presence of MNFs. The MNFs have, on the other hand, no effect on non-MNF productivity in regions where the high-productive non-MNFs are located.

Keywords: Multinational firms, affiliates, productivity, R&D, knowledge, spillovers, skilled workers, region

JEL-codes: F23, J24, O33, R11

1. Introduction

The role of multinational firms (MNFs) has become crucial for the global connectivity of an urban region, and urban regions in turn are seen more and more to drive national economies (McCann & Acs, 2011). Existing economic theory identifies a range of possible spillover channels by which MNFs may generate benefits to the receiving economies including benefits for exiting domestic firms, not least in the form of knowledge spillovers. Such knowledge spillovers, for example, may lead to higher productivity levels and/or productivity growth in domestic firms. Many governments in developed as well as developing and transition countries also strive to attract MNFs to invest in their countries with the belief that knowledge brought by MNFs will spill over to domestic firms and increase their productivity and thus their competitiveness. This issue naturally has attracted researchers to do a substantial number of studies of the productivity effects in host countries of the presence of MNFs in both developed and less developed economies.

However, most studies of knowledge spillovers from MNFs have been performed at the national level. One could question whether this is a proper level, since there are considerable evidences in the literature that knowledge spillovers are spatially restricted (Karlsson & Manduchi, 2001) and that the costs of transmitting knowledge rises with distance (Audretsch & Feldman, 1996). Large research-intensive MNFs function as anchor-tenants and generate qualities to the economic milieu in which they are located. These anchor-tenants support the evolution of knowledge and competencies in each individual labour market region (Andersson et al. 2010). Hence, productivity effects on domestic firms of knowledge spillovers from MNFs is preferably analysed at the level of labour market regions.

This paper examines whether the local presence of MNF affiliates generate spillover effects on the local industry. We make use of Swedish data that allow us to distinguish between manufacturing production of non-affiliated firms and MNF affiliates, respectively, in different regions. The empirical analysis focuses on assessing whether the productivity of the regional manufacturing industry of non-affiliated firms is higher in regions with a large fraction of MNF affiliates. The paper also investigates whether the effect from local presence of MNFs on the productivity of the non-MNFs differs among regions in Sweden.

The remainder of the paper is organized as follows: Section 2 discusses the role of productivity spillover channels. In section 3, data and descriptive statistics are presented. The empirical strategy is discussed in section 4. The regression results are presented in section 5. Conclusions are given in section 6.

2. Productivity Spillover Channels

Productivity spillovers from MNFs take place when the entry or presence of MNFs increases the productivity of domestic firms in the host economy and the MNFs do not fully internalize the value of these benefits. The belief of such spillovers from MNFs is based on the expectation that these firms must have firm-specific productivity advantages based upon technological and knowledge assets. These productivity advantages make it possible for them to get compensation for the higher costs due to unfamiliar demand and supply conditions they must cover when they make foreign direct investments (FDIs), in foreign markets compared with exporting their products to these markets (Hymer, 1976; Dunning, 1993).[1] There is also substantial evidence that MNFs have a productivity

[1] It is important to remember that FDIs are undertaken for different purposes and not only as a substitute for exports. One motivation is, for example, to decrease production costs by locating in low cost regions. Another motivation is the acquisition of technological knowledge or technology sourcing from the host

advantage compared to domestic firms (Girma, Greenway & Wakelin, 2001; Griffith & Simpson, 2004).

The productivity spillovers may be either intra-industry, i.e. horizontal or inter-industry, i.e. vertical, spillovers. The presence of MNFs may induce productivity increases in firms in the host region through different knowledge 'spillover' channels (see e.g. Blomström & Kokko, 1998; Smarzynska Javorcik, 2004):

1. Skilled employees may leave MNFs, take employment in domestic firms in the region, and bring knowledge with them that can be applied by their new employer to raise the productivity.

2. Skilled employees may leave MNFs and start new firms in the region with a superior productivity than incumbent domestic firms, which may force incumbents to leave the market.

3. There may exist "demonstration effects" in the sense that domestic firms may learn superior production technologies from MNFs when there are arm's-length relationships between MNFs and domestic firms.

4. Domestic firms may learn how to improve productivity from MNFs via backward and forward linkages.

5. Knowledge may spill over from MNFs to domestic firms via joint research projects.

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region (Fosfuri & Motta, 1999; Kogut & Chang, 1991; Neven & Siotis, 1996; Cantwell & Janne, 1999, Cantwell & Zhang, 2011). Moreover, Narula & Santangelo (2012) argue that in addition to location-specific advantages that are industry-specific there are also collocation advantages that explain the spatial distrbution of MNF R&D activity. Collocation advantages derive from spatial proximity to specific unaffiliated firms, which may be suppliers, competitors, or customers. Driffield & Love (2006) using industry-aggregated FDI flows for the UK conclude that technology-sourcing FDI has detrimental effects on the domestic sector's productivity trajectory.

6. Domestic firms may be forced by rival MNFs to up-date their production technologies and products and thus become more productive – a competition effect.[2]

7. The presence of MNFs may induce the entry of international trade brokers, accounting firms, consultancy firms, and other professional service firms, whose services also may become available to domestic firms.

8. Local ownership participation in FDI projects (Beamish, 1988; Blomström & Sjöholm, 1999; Smarzynska Javorcik & Spatareanu, 2008).

What is important to observe is that knowledge spillovers can be both intentional and unintentional. MNFs like any other firm are of course eager to try to prevent knowledge to leak to competitors so that they can improve their performance. On the other hand, many MNFs provide inputs or capital equipment to their customers and in those cases, knowledge is so to say part of the deal. MNFs are also customers in the host economy and as qualified and demanding customers with high quality requirements; they may transfer knowledge to their suppliers to increase the quality of the inputs they buy from them. This implies that the nature and extent of productivity spillovers from MNFs partly depend upon the motivation of MNFs for undertaking them (Cantwell & Narula, 2001; Driffield & Love, 2006).

It is important to stress that the spatial range of the different types of knowledge flows differ since the geographical transaction costs differ with the type of knowledge flow (Johansson & Karlsson, 2001; Döring & Schnellenbach, 2006). One could argue that the higher the degree of tacitness of the actual knowledge, the higher the geographical

[2] Competition from MNFs may also reduce productivity in domestic firms if MNFs are able to attract demand away from them (Aitken & Harrison, 1999).

transaction costs and thus the shorter the distance over which the knowledge is communicated between independent economic agents.[3] Moreover, the literature in the field of knowledge flows stress the importance of that the receiving firms have the necessary absorptive capacity to absorb and apply the new knowledge, which becomes available through the different knowledge channels (Cohen & Levinthal, 1999; Mariani, 2000; Verspagen & Schoenemakers, 2000; Maurseth & Verspagen, 2002). The underlying reason is that knowledge is acquired in a cumulative learning process, which implies that new knowledge can only be evaluated, absorbed and applied if the necessary complementary knowledge is already in place.

From this short overview, it is obvious that the various types of knowledge flows, which might influence productivity, are difficult to trace and to measure. As a result, much of the literature actually mainly avoids the question of how different knowledge flows from MNFs actually influence productivity in domestic firms. Instead, most studies try to test whether the presence of MNFs affects the productivity in domestic firms. The most common method has econometric analyses where it is tested whether the presence of MNFs has a significant effect on labour productivity or total factor productivity in domestic firms when using relevant control variables. If the parameter estimate for the MNF presence is positive and statistically significant, it is assumed that there is evidence of knowledge spillovers from MNFs to domestic firms.

The literature in the field contains a rather large number of industry- and firm-level studies from various counties. Most of these studies show a positive correlation between the presence of MNFs and the average labour productivity in different industries (Caves,

[3] Knowledge communication within economic agents normally has lower geographical transaction costs. One may even argue that one reason why is that MNFs can economize on the geographical transaction costs of transferring knowledge between different geographical locations.

1974; Globerman, 1979; Blomström & Persson, 1983; Blomström 1986; Blomström & Wolff, 1994; Kokko, 1994; Kokko, 1996, Liu, et al., 2000; Driffield & Munday, 2000; Driffield, 2001) or firms (Kokko, Tansini & Zejan, 1996; Blomström & Sjöholm, 1999; Chuang & Lin, 1999; Sjöholm, 1999a & b). However, most of them rely on cross-sectional data, which implies that they are unable to establish the direction of causality.[4] It may be the case, for example, that MNFs tend to invest in industries with high labour productivity, when they invest in a country. It is also possible that MNFs out-compete domestic firms in the industries they invest in or that they by taking a large market share increase the average productivity in their industry.

Another type of studies in the literature is based upon firm-level panel data. Here the research question concerns whether the productivity of domestic firms increases with the presence of MNFs. The results go in two directions. Studies of developing and transition countries seem to generate either no significant effects or significant negative horizontal spillovers (Haddad & Harrison, 1993; Aitken & Harrison, 1999; Djankov & Hoekman, 2000; Kathuria, 2000; Konings, 2001; Narula & Dunning, 2010), while studies of developed countries seem to tend to generate evidence of significant positive productivity spillovers from MNFs (Haskel, Pereira & Slaughter, 2007; Keller & Yeaple, 2009).[5] Thus, the presence of MNFs in developing countries seems to have a negative effect on the productivity of domestic firms active in the same sector. The reason might be that domestic firms lose market shares to MNFs, and thus must distribute their fixed costs over a smaller production volume (Aitken & Harrison, 1999).

[4] It should be observed that Blomström (1986) and Blomström & Wolff (1994) studied changes taking place between two points in time and Liu, et al., (2000) used panel data.

[5] The study of UK by Girma, Greenaway & Wakelin (2001) did generate insignificant results.

A rather small number of studies tests for productivity spillovers from MNFs taking place through backward and forward linkages, and some find evidence for the presence of productivity spillovers taking place through backward linkages from foreign affiliates to their domestic suppliers (Blalock, 2001; Smarzynska Javorcik, 2004; Blalock & Gertler, 2008).[6] The literature also contains studies, which give evidence that vertical spillovers are associated with shared domestic and foreign ownership but not fully owned foreign subsidiaries (Smarzynska Javorcik & Spatareanu, 2008).

Most studies of productivity spillovers from MNFs have been conducted at the national level. One could question whether this is the right level for this kind of studies. There is today a rich literature supported by substantial evidences that knowledge spillovers are spatially restricted (Karlsson & Manduchi, 2001) and that the costs of transmitting knowledge rises with distance (Audretsch & Feldman, 1996), in particular to the extent that knowledge is tacit and uncodified. A fundamental reason for this is that the diffusion of the critical knowledge mainly is done in three ways: i) (frequent) face-to-face interaction between people (Jaffe, Trajtenberg & Henderson, 1993; Anselin, Varga & Acs, 1997), ii) the mobility of employees between employers (Matusik & Hill, 1998)[7], and iii) direct contacts between suppliers and customers which often tend to be local to minimize transport costs and to facilitate communication.[8] Due to the tyranny of distance, frequent face-to-face interaction only can take place between people located in

[6] Schoors & van der Tol (2001) provide evidence of positive spillovers from MNFs through backward linkages using cross-sectional firm-level data from Hungary.

[7] It is claimed that the training of employees by MNFs and subsequent labour turnover is one of the major technology transfer mechanisms (Fosfuri, Motta & Thomas, 2001). Since the mobility of labour between regions is low (Greenaway, Upward & Wright, 2002), it is likely that most of the productivity spillovers from MNFs will be experienced locally. However, MNFs dispose of instruments that can reduce this kind of knowledge spillovers (Fosfuri, Motta & Ronde, 2001; Fosfuri & Ronde, 2004).

[8] It is also possible that demonstration effects mainly are local if firms only observe and imitate firms in the same region (Blomström & Kokko, 1998).

the same (labour market) region. In addition, most people changing jobs do it within the region where they live.

Several authors stress the role of the spatially bounded regional innovation networks for the diffusion of knowledge between economic agents (Wilkinson & Moore, 2000; Andersson & Karlsson, 2004). Knowledge may flow more easily between economic agents located in the same region thanks to different social bonds that foster reciprocal trust and frequent face-to-face contacts given that the proper institutional framework exists (Marshall, 1980; Landes, 1998; Döring & Schnellenbach, 2006). There seems today to be a substantial empirical consensus that knowledge flows tend to be spatially bounded (Jaffe, Trajtenberg & Henderson, 1993; Audretsch & Feldman, 1996; Feldman & Audretsch, 1996; Henderson, 1997; Fritsch & Lucas, 1998; Funke & Niebuhr, 2000; Niebuhr, 2000; Paci & Pigliaru, 2001; Gråsjö, 2006).

The natural conclusion to draw is that productivity effects on domestic firms from the presence of MNF should be analysed at the level of labour market regions, or what could be called functional regions, since there are strong reasons to assume that most productivity spillover, to the extent that they exist probably will be spatially bounded. However, there is a general lack of regional data, which explains why so few studies of the productivity effects of MNFs have been done at the regional level. Exemptions are

- Girma & Wakelin (2001) and Girma (2005), who found that intra-industry productivity spillovers are more pronounced in the region where the MNFs are located, which indicates that spatial proximity is important.

- Driffield (2000), who found that there are positive productivity spillovers from MNFs in the same sector and same region in the UK.[9]

- Griffith & Simpson (2004), who found a faster catch-up by domestic firms to the technological frontier within the region in the UK due to localized intra-industry spillovers from MNFs.

- Girma & Wakelin (2009) who concluded that domestic firms gain from the presence of MNFs in the same sector and region, but lose if the firms are located in a different region but the same sector. The authors also found that less-developed regions gained less from spillovers than other regions.

To the extent that productivity improving knowledge flows from MNFs to domestic firms exist at the regional level we expect them

- to increase with the density of the region, since dense regions offer better opportunities for face-to-face interaction,

- to increase with the size of the region, since the frequency of people changing jobs a given year increases with the size of regions (Andersson & Thulin, 2008),

- to increase with the educational level of the regional workforce and its experience[10], since the absorptive capacity[11] increases with the educational level

[9] MNFs in the sector but outside the region seem to have a negative impact on productivity, presumably due to increased competition (Driffield, 2000).

[10] It is conceivable that some individuals cannot make use of new, although perhaps superior, knowledge simply because they lack the necessary complementary knowledge due to that they have not been able to accumulate it during their specific learning path (Döring & Schnellenbach, 2006).

[11] It is a common assumption in the literature that firms need a certain level of absorptive capacity to benefit from productivity spillovers from other firms (Lapan & Bardhan, 1973; Cohen & Levinthal, 1989). Girma (2005) also find evidence that more absorptive capacity speeds up spillovers from MNFs.

and since the frequency of people changing jobs a given year increases with their educational level (Andersson & Thulin, 2008),

- to increase with the productivity level in the region (Mariani, 2000; Verspagen & Schoenemakers, 2000; Maurseth & Verspagen, 2002),

- to increase with the technology gap between the MNFs and domestic firms in the region (Findlay, 1978; Wang & Blomström, 1992; Sjöholm 1999a & b; Jordaan 2005 & 2008; Haskel, Pereira & Slaughter, 2007)

- to increase with the average size of domestic firms in the region, since smaller firms seems to lack the necessary absorptive capacity to benefit from spillovers from MNFs (Girma & Wakelin, 2001).

Whether the productivity improving knowledge flows from MNFs to domestic firms at the regional level mainly are intra- or inter-industrial is an empirical question. There are theoretical arguments for and against both types of knowledge flows, and earlier empirical results from studies at the regional level are not conclusive.

To demonstrate empirically the relevance and extent of knowledge flows from MNFs to domestic firms at the regional level, it is in principle necessary to demonstrate, that domestic firms to a significant extent are appropriating knowledge externalities. Two major approaches have been used in the literature, one based upon micro-economic data and one based upon aggregate data. The micro-economic approach is characterized by efforts to recreate the actual knowledge flows, for example, by analysing patent citations and their spatial distribution (e.g. Jaffe, Trajtenberg & Henderson, 1993), or the mobility of so-called star-scientists. The aggregated approach, for example, has estimated so called knowledge production functions (Griliches, 1979) to see how the knowledge

output in different regions, for example, in terms of patents, can be explained by various R&D inputs and different control variables at the regional level (Gråsjö, 2006). This approach allows for testing of hypotheses about the impact of knowledge flows from academic research but also about the existence of intra- and inter-industry knowledge "spillovers" within and between regions.[12]

3. Data and descriptive statistics

We make use of data on data maintained by Statistics Sweden, which comprise firm-level balance-sheet information on firms on a yearly basis between 1997 and 2004. Firms are defined as legal entities. Four sources of data have been matched. The basic data comprise balance-sheet information for every firm and includes information on employment, value-added, sales, gross investments, short- and long-run debts, etc. The second data source is the Swedish employment database (RAMS) which provides information on the education structure of each firm's employees. The third data source is a database of the ownership structure of firms. These data provide information on whether a firm is an independent firm or belongs to a domestic corporation, a domestic multinational or a foreign multinational. The fourth set of data provides information on how much each firm is exporting and importing to and from each country and year. Exports and imports by country and year are measured in value and volume (kilogram).

Each firm is assigned to a given functional region through a spatial identifier. A drawback of the data is that it does not contain information on whether a given firm is a multi-plant firm or not. However, multi-plant phenomena are mostly a feature of corporations. We observe individual firms and have information on whether they are part

[12] Regional interdependence has also been studied using different measures for spatial autocorrelation based upon, for example, the coefficient proposed by Moran (1959).

of a corporation (uninational or multinational). The different plants of corporations like Volvo, Ericsson and SAAB in Sweden are often registered as distinct legal entities, i.e. firms. A region is defined as a *functional region*. A functional region consists of several municipalities that together form an integrated local labour market. They are delineated based on the intensity of commuting flows between municipalities. We use a definition of functional regions in which there are 72 regions in Sweden.[13] As in Andersson, Lööf and Johansson (2008) we impose a censoring level on 10 employees for each individual year.

4. Empirical strategy

We conduct two types of estimations. First, we aggregate the data over functional regions such that we get average value-added per employee amongst non-affiliate firms in each region and year[14]. We then examine whether the local presence of MNE affiliates is associated with the average labour productivity of non-affiliate firms in a region, while controlling for other regional characteristics. Specifically, we estimate the following panel data model on regional level:

$$\ln y_j = \alpha + \beta_1 M_j + \beta_2 \ln S_j + \beta_3 E_j + \beta_4 E_j^{MNF} + \beta_5 D_S + \varepsilon_j$$

where,

$y_j =$ Gross regional product (GRP) per employee from non-MNFs in region j

$M_j =$ GRP share from MNFs in region j (local presence of MNF)

$S_j =$ Size (number employed) of region j

[13] Developed by NUTEK – the Swedish Agency for Economic and Regional Growth.

[14] For a simpler notation we have dropped the sub-index *t* for time (year 1997-2004) in the equations that follow.

E_j = Employment share in non-MNFs with high education in region *j*

E_j^{MNF} = Employment share in MNFs with high education in region *j*

D_S = Dummy variable for the Stockholm region

To qualify the results obtained with regional aggregated data, we make use of firm-level observations and estimate a basic labour-productivity function extended with regional characteristics on data non-affiliate manufacturing firms. Our focus is here on testing whether a positive effect of the local presence of MNE-affiliated firms remains when controlling for attributes of the individual non-affiliated firms. A firm-level approach is warranted for several reasons. First, the theory of MNE spillovers is truly micro-economic in nature, making postulations about how individual firms are affected by proximity to MNE-affiliates. Second, a firm-level approach allows us to estimate the effect of the external local environment of a firm on its productivity, while accounting for an ample set of firm attributes. Controlling for attributes of individual firms reduces, for instance, the likelihood that estimated effects of agglomeration on productivity are driven by differences in internal firm attributes across locations. This is important, as the magnitude of heterogeneity in resources across firms is substantial. A key assertion in the literature adhering to the resource-based view of the firm (RBV) is, for example, that a firm's competitive advantage depends critically on its internal resources and capabilities (Penrose 1959, Barney 1991). This approach may be compared with Moretti (2004) and Henderson (2003), who estimate plant-level production functions that are extended with variables reflecting the local environment. Moretti (2004) focuses on the education-level of the employees in the region, whereas Henderson (2003) focuses on the number of other firms in the same industry in the region as a source of spillover effects. Specifically, we estimate the following model using firm-level data:

$$\ln y_i = a + b_1 M_j + b_2 \ln S_j + b_3 \ln K_i + b_4 \ln L_i + b_5 \ln C_i + b_6 D_i^{xz} + b_7 D_i^{x} + b_8 D_i^{z} + e_i$$

where,

$y_i =$ Production (value added) per employee from non-MNF *i*

$M_j =$ GRP share from MNFs in region *j* where firm *i* is located (local presence of MNF)

$S_j =$ Size (number employed) of region *j*

$K_i =$ Labor with high education in non MNF *i* (knowledge labor)

$L_i =$ Labor (ordinary) in non MNF *i*

$C_i =$ Capital in non MNF *i*

$D_i^{XZ} =$ Dummy variable indicating if firm *i* is an exporter and an importer

$D_i^{X} =$ Dummy variable indicating if firm *i* is only an exporter

$D_i^{Z} =$ Dummy variable indicating if firm *i* is only and an importer

5. Regression results

As mentioned in previous section regressions are conducted on regional level as well as on firm level. As a complement to pooled OLS and fixed effects panel regressions (including fixed effects vector decomposition, XTFEVD), estimations on regional level are also conducted with the quantile regression technique (Koenker and Bassett, 1978). With the use of this method, we investigate how the impact of local presence of MNF's (and other covariates) varies among regions at different levels of the dependent variable. The main advantage with the quantile regression technique is its semi-parametric nature, which relaxes the restrictions on the parameters to be constant across the entire distribution of the dependent variable. An important motivation for quantile regressions has been its inherent robustness to outlying observations in the response variable. The

quantile regression estimator gives less weight to outliers of the dependent variable than least squares estimators.[15] Besides being robust to outliers, the technique is also robust to potential heteroscedasticity. This is achieved because the parameter estimates for the marginal effects of the explanatory variables are allowed to differ across the quantiles of the dependent variable.

Regional level

A multicollinerity problem arises if M_j i.e. local presence of MNFs and the size variable S_j are used together as explanatory variables. This is evident from Table 5.1 where the results from pooled OLS and XTFEVD regressions are presented. In regression (2) and (5), the size of a region has a positive effect on GRP per employee from non-MNFs while the effect of local presence of MNFs appears to negative. However, when M_j and S_j are used separately both variables have a positive impact on GRP. Hence, even if it is difficult to separate between the effects and to determine the magnitude of the effects, local presence of MNFs in a region seems to affect positively GRP from non MNFs. Highly educated labour in both MNFs and non-MNFs has a positive impact on productivity, which is apparent in the panel regressions (4), (5) and (6). On average, the non-MNFs in the Stockholm region are less productive compared to MNFs in the rest of the country.

[15] The θth regression quantile of the dependent variable *y* is the solution to the minimization of the sum of absolute deviations residuals

$$\min_{\beta} \frac{1}{n}\left(\sum_{i:y_i \geq x_i'\beta} |y_i - x_i'\beta|\theta + \sum_{i:y<x_i'\beta} |y_i - x_i'\beta|(1-\theta) \right)$$

Different quantiles are estimated by weighing the residuals differently. For the median regression, all residuals receive equal weight. However, when estimating the 75th percentile, negative residuals are weighed by 0.25 and positive residuals by 0.75. The criterion is minimized, when 75 percent of the residuals are negative. In contrast to OLS, the equation above cannot be solved explicitly since the objective function is not differentiable at the origin, but it can be solved with linear programming (see e.g. Buchinsky, 1998).

Table 5.1 Regression results, regional level. Dependent variable: log GRP per employee from non-MNFs.

	Pooled OLS			XTFEVD		
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Educ non-MNF, E_j	0.583	0.371	0.892	3.334	3.192	3.144
	(1.46)	(1.00)	(1.80)*	(12.82)***	(12.15)***	(12.35)***
Educ MNF, E_j^{MNF}	-0.075	0.091	0.474	0.557	0.638	0.645
	(0.51)	(0.60)	(2.52)**	(5.02)***	(5.57)***	(5.71)***
$D_{Stockholm}$	-0.223	-0.250	-0.168	-0.374	-0.393	-0.301
	(2.25)**	(2.48)**	(1.63)	(9.76)***	(10.17)***	(7.79)***
Size, ln S_j	0.042	0.054		0.022	0.032	
	(11.09)***	(12.12)***		(7.40)***	(8.88)***	
Local pres. MNF, M_j		-0.123	0.067		-0.096	0.038
		(4.86)***	(2.65)***		(4.48)***	(2.14)**
Constant	5.573	5.537	5.837	5.695	5.669	5.849
	(187.99)***	(183.19)***	(324.45)***	(265.12)***	(257.10)***	(520.26)***
Observations	648	648	648	648	648	648
R-squared	0.38	0.40	0.23	0.55	0.55	0.53

* significant at 10%; ** significant at 5%; *** significant at 1%

Robust t statistics in parentheses

Quantile regressions are conducted on the model where the size variable is excluded for Q1, Q5, Q10, …, Q95, Q99. The results are presented graphically in Figure 5.1-5.3. In order to solve potential heteroscedasticity problems, bootstrap with 2,000 replications are conducted.[16] The 95% confidence band from bootstrapped estimation errors are shown as dotted lines. Consequently, given a specific quantile, if both the upper and the lower confidence limit are above/below zero, then the parameter estimate is positive/negative and statistically significant. In Figure 5.1, it is obvious that the effect from local presence of MNFs is not constant across the regions in Sweden. Regions where we find the low-productive non-MNFs appear to benefit the most from local presence of MNFs. The

[16] The standard errors are usually underestimated for data sets with heteroscedastic error distributions (Rogers, 1992). Therefore, standard errors will be obtained by bootstrapping the entire vector of observations (Gould, 1992). This procedure is automated in the STATA statistical package.

MNFs have, on the other hand, no effect (or worse, a negative effect) in regions where the high-productive non-MNFs are located. The effects of highly educated labour in non-MNFs (Fig. 5.2) and in MNFs (Fig 5.3) are more unclear. However, when a region benefits from highly educated labour in non-MNFs, the effect from highly educated labour in MNFs is minor and vice versa.

Figure 5.1 Effects of local presence of MNFs

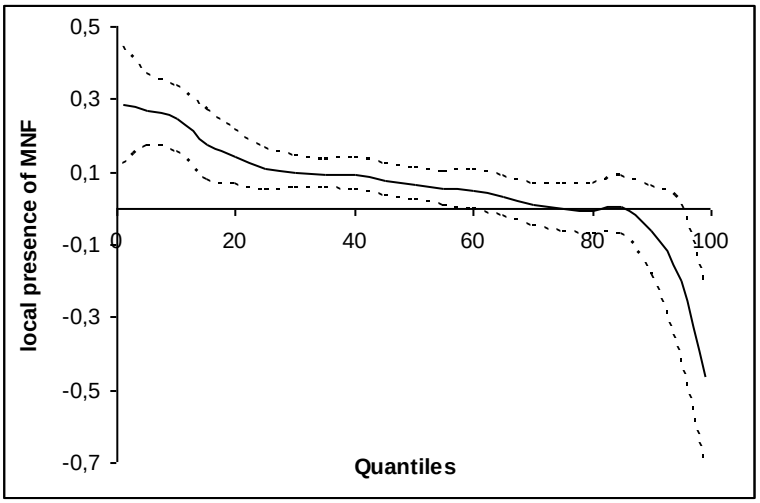


Figure 5.2 Effects of high education in non-MNFs

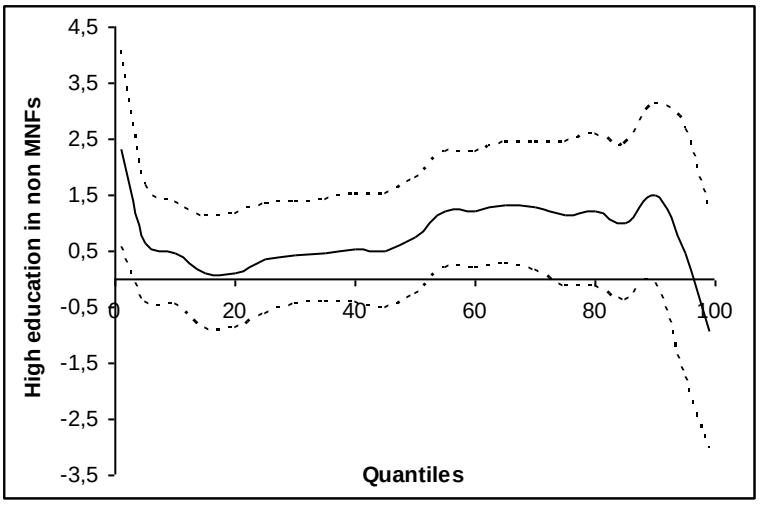
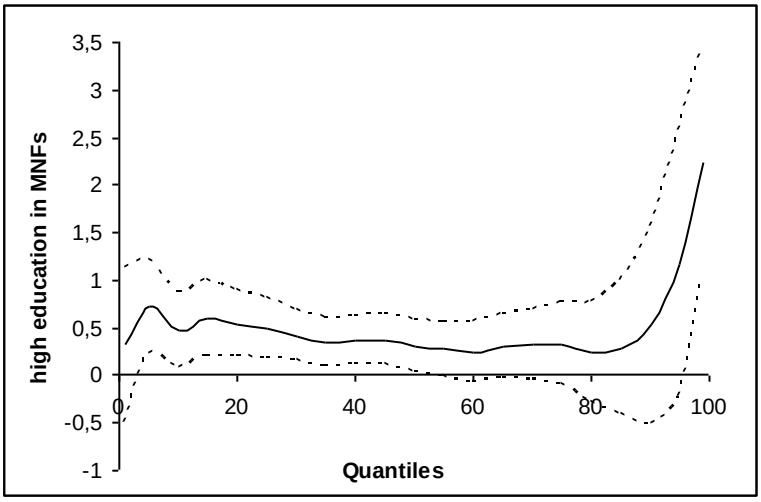


Figure 5.3 The effect of high education in MNFs



Firm level

The results are unambiguous on firm level (see Table 5.2 and Table 5.3). Local presence of MNFs as well as the size of the region has a positive effect on non-MNFs productivity level. Hence, a non-MNF benefits from being located in a large region where we also find MNF affiliates. Furthermore, highly educated labour and capital improve the firm productivity, while ordinary labour seems to have a negative effect. As expected, non-affiliated MNFs engaged in international trade are the most productive firms. This is especially true for firms being both exporters and importers.

Table 5.2 Regression results from pooled OLS, firm level. Dependent variable: log value added per employee in non-MNFs.

	Pooled OLS		
	(1)	(2)	(3)
Knowledge labour, in K_i	0.065	0.065	0.068
	(23.94)***	(23.92)***	(24.51)***
Ordinary labour, in L_i	-0.337	-0.337	-0.337
	(35.03)***	(35.03)***	(35.32)***
Capital, ln C_i	0.132	0.132	0.129
	(38.47)***	(38.49)***	(38.26)***
Exporter & importer, D_i^{XZ}	*0.095*	0.095	0.097
	*(12.97)***	(12.97)***	(13.32)***
Exporter, D_i^X	0.020	0.020	0.022
	(2.55)**	(2.57)**	(2.86)***
Importer, D_i^Z	0.022	0.022	0.023
	(1.93)*	(1.92)*	(2.10)**
Size, ln S_j	0.026	0.025	
	(13.24)***	(11.71)***	
Local pres. MNF, M_j		0.016	0.115
		(0.84)	(6.65)***
Constant	3.482	3.479	3.717
	(94.88)***	(94.74)***	(124.16)***
Observations	20917	20915	21280
R-squared	0.30	0.30	0.30

Robust t statistics in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 5.3 Regression results from panel regressions, firm level. Dependent variable: log value added per employee in non-MNFs.

	(1) Fixed effects	(2) Fixed effects	(3) XTFEVD
Knowledge labour, ln K_i	0.041	0.040	0.040
	(10.46)***	(10.39)***	(28.69)***
Ordinary labour, ln L_i	-0.630	-0.629	-0.629
	(29.96)***	(30.01)***	(178.89)***
Capital, ln C_i	0.117	0.117	0.117
	(17.77)***	(17.73)***	(84.38)***
Exporter & importer, D_i^{XZ}	0.073	0.072	0.072
	(6.74)***	(6.65)***	(16.19)***
Exporter, D_i^{X}	0.035	0.035	0.035
	(3.94)***	(3.96)***	(6.56)***
Importer, D_i^{Z}	0.036	0.036	0.036
	(3.32)***	(3.30)***	(5.03)***
Size, ln S_j	0.159	0.146	0.019
	(5.17)***	(4.75)***	(13.94)***
Local pres. MNF, M_j		0.139	0.023
		(4.94)***	(1.82)*
Constant	3.199	3.256	4.719
	(9.59)***	(9.87)***	(247.33)***
Observations	20917	20915	20915
Number of id	6150	6150	
R-squared	0.25	0.25	0.78

* significant at 10%; ** significant at 5%; *** significant at 1%, t statistics in parentheses

6. Conclusions

This paper has focused on to what extent the productivity of the local industry benefits from MNF affiliates located in the same region. The analysis was conducted on firm level as well as on regional level.

The regression results showed that local presence of MNFs in a region has a positive effect on the productivity of non-MNFs. This was the case on both firm and regional level. However, the effect was not constant across regions. By using the quantile

regression technique, it was shown that the low-productive regions benefit the most from MNF affiliates being located in the region. On the contrary, MNF affiliates have no effect or a negative effect in the regions where the high-productive non-MNFs are located. These findings suggest that a large technology gap promotes positive spillovers between MNFs and domestic firms in the region. Furthermore, highly educated labour in non-MNFs has a positive effect on productivity, while the effect from ordinary labour is negative. The productivity is also higher if the non-MNFs are engaged in international trade, especially if the firms deal with both exports and imports.

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