FDI MOTIVES AND HOST COUNTRY PRODUCTIVITY EFFECTS OF US MNEs*

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THIS VERSION: September 2008

ABSTRACT

In this paper we investigate the productivity effects of technology seeking and exploiting FDI. Although the positive effects of technology exploiting FDI are fairly widely accepted, this is not the case for technology seeking FDI, due to its inherent "knowledge-absorbing" nature. Nonetheless, based on four arguments distilled from previous literature, we claim that the productivity effects of technology seeking FDI may indeed be expected to be positive, and as least as large as those of technology exploiting FDI. Using a new industry-level dataset of US MNEs' subsidiaries, active in 14 OECD countries over the period 1987-2003, we find broad and consistent support for this claim.

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* This project was initiated while the second author was visiting Rutgers Business School (RBS), Newark, New Jersey. He would like to thank RBS for its hospitality.

INTRODUCTION

The cumulative ambiguity in empirical results regarding the productivity enhancing effects of inward Foreign Direct Investment (FDI) or 'spillovers' has led scholars to start investigating such effects in more detail (Smeets, 2008). Some studies try to disentangle the knowledge diffusion channels through which such effects allegedly take place (Javorcik, 2004; Görg and Strobl, 2005), while others have considered the moderating role of factors such as the absorptive capacity of local firms (Girma, 2005; Girma and Görg, 2007) or the geography of inter-firm patterns of location (Barrios, Bertinelli and Strobl, 2007; Nicolini and Resmini, 2007).

A more recent stream of literature has approached the issue by acknowledging the fact that multinationals (MNEs) and their foreign subsidiaries are not homogenous, and as such may generate different (productivity) effects on host-country firms (Keane and Feinberg, 2005). In this vain, some authors have investigated the influence of differences in MNE ownership structures (Javorcik and Spatareanu, 2008), parent nationality (Buckley, Clegg and Wang, 2007*ab*) and market orientation (Girma, Görg and Pisu, 2008).

One form of MNE heterogeneity that has to date received much less attention in the FDI spillover literature is that of heterogeneity in investment motives, and in particular the distinction between *technology seeking FDI* vis-à-vis *technology exploiting FDI* .[1] Various scholars have examined *inter alia* the characteristics of companies involved in these two types of FDI (Kuemmerle, 1999; Le Bas and Sierra, 2002; Cantwell and Mudambi, 2005; Berry, 2006) and the regional characteristics that attract these different FDI types (Cantwell and Piscitello, 2005; 2007). These studies find persistent differences between the two types of FDI, which suggests that their effects on their host-country environment may also differ.

Contrary to some recent contributions by Girma (2005) and Driffield and Love (2007), our main claim in this paper is that technology seeking FDI will generate positive productivity effects in the host country, and that these effects will be at least as great as those associated with technology exploiting FDI. We support this claim by four arguments which can be discerned in the literature. These arguments relate to the

[1] Two recent exceptions are Girma (2005) and Driffield and Love (2007).

R&D intensity, the firm characteristics, the general nature of knowledge diffusion, and the competition effects of the two different types of FDI.

We then empirically test the relationship between technology seeking and exploiting FDI on the one hand, and productivity effects on the other, using a new industry-level dataset of the foreign activities of US MNEs in 14 OECD countries over the period 1987-2003. Our results are supportive of the expectation that technology seeking FDI is highly conducive to positive productivity effects in the host country, and moreover, that these effects are quantitatively greater than those that arise from technology exploiting FDI.

The rest of the paper is structured as follows: In the subsequent section we will review the literature on FDI motives, and spell out the four arguments that support our claim regarding the positive productivity effects of technology seeking FDI. Section 3 presents the data and the empirical methodology that we employ in this paper, and Section 4 reports the empirical results. Section 5 concludes the paper.

THEORY

FDI motives and productivity effects

The traditional literature on the MNE either implicitly or explicitly refers to the technology exploiting motive of Foreign Direct Investment (Hymer, 1976; Dunning, 1977). That is, in order to overcome its *liability of foreignness*, a MNE and its subsidiary have to possess some firm-specific competitive advantage in order to be able to compete with local (foreign) firms. This firm-specific advantage (Rugman, 1981) or nationality of ownership advantage (Dunning, 1958) has often been associated with a technological competence or asset (Markusen, 2001), which is capable of being transferred and thus exploited in other suitably advantaged locations.

Yet in more recent years, a complementary motive for FDI has been increasingly recognized, in which a MNE is argued to benefit from the international scope of its activities by seeking or sourcing technology-based assets from its foreign-located counterparts. The articulation within the firm of this MNE motive or strategy may be the initially unplanned outcome of the evolution over time of selected subsidiaries (Birkinshaw and Hood, 1998), that as they have matured have become increasingly capable of local initiatives, entrepreneurship and new business network creation (Birkinshaw, 1997; Forsgren, Holm and Johanson, 2005). This locally competence creating type of FDI has sometimes been termed technology seeking or asset augmenting FDI (Dunning and Narula, 1993; Kuemmerle, 1999; Le Bas and Sierra, 2002).

Inspired by the recent trend to examine more closely the interaction between MNE heterogeneity of motives and host-country locational characteristics, Girma (2005) and Driffield and Love (2007) study the extent to which these differing FDI motives generate different productivity effects in the UK. In both these studies, the distinction between technology exploiting and seeking FDI is based *inter alia* on relative R&D intensities (RDIs) between the home and the host country. [2] It is argued that since FDI with a technology seeking motive is aimed at seeking or sourcing technology in the host country in fields in which the MNE is lacking, it can reasonably be expected that the RDI of the home country-industry of the MNE is lower than that of the host country-industry, assuming that MNEs are at least on average representative of the areas from which they originate. Hence, if the ratio of home country RDI over host country RDI is less than one, FDI is defined to be of a technology seeking type. If it is greater than one, it is termed technology exploiting FDI.

Since technology seeking FDI (by definition or assumption) originates in terms of its country of ownership from less R&D intensive industries when compared to the equivalent industries in the host locations in which it is sited, it is hypothesized that technology seeking FDI will not induce any knowledge diffusion to local actors in the host country. The reverse holds for technology exploiting FDI, which is thus expected to induce positive knowledge diffusion, given the relative home country technological advantage. Both Girma (2005) and Driffield and Love (2007) find broad support for these hypothesized effects.[3]

In the remainder of this section we will question the basic premise behind this argument, i.e. that technology seeking FDI is characterized as that which runs between industries with home-host RDI ratios smaller than one. Our line of reasoning follows four strands of alternative thinking on this issue. The (expected) R&D

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[2] RDI is measured as R&D expenditures as a percentage of value added (at the industry level).

[3] The study by Driffield and Love (2007) also makes an additional distinction based on whether or not there is an efficiency seeking motive for the FDI involved. Essentially, this efficiency seeking motive is expected to depress any positive diffusion effects of FDI because of the negative competition effects (based on lower host-country labor costs) it generates.

intensity of technology seeking FDI, the general firm characteristics of technology seeking firms, the reciprocal nature of knowledge diffusion, and the likely degree of competition effects of technology seeking FDI. We then formulate two hypotheses regarding the productivity effects of technology exploiting and seeking FDI.

Subsidiary mandates and R&D responsibilities

A recent and increasing microeconomic literature has investigated the relationship between subsidiary mandates (that may include either or both technology exploiting or seeking roles) and the corresponding R&D assignments or responsibilities that are likely to be received by the subsidiaries in question. Although such studies do not directly address the question of the productivity effects generated by MNE subsidiaries, they do shed some light on the extent and nature of R&D responsibilities of technology seeking affiliates.

Feinberg and Gupta (2004) investigate the determinants of R&D assignments by MNEs to their foreign subsidiaries, distinguishing between external (to the firm) and internal determinants of this decision. Among other factors, they argue and show that the extent to which the external host country environment provides knowledge spillover opportunities is positively related to the extent of R&D responsibilities assigned to subsidiaries in the host country. The argument here is that increased R&D at the subsidiary level allows the subsidiary to better absorb the external knowledge (Cohen and Levinthal, 1989; Minbaeva et al., 2003). It also implies that subsidiaries with a technology seeking mandate are more effective at acting on this mandate if they receive significant R&D responsibilities from the parent.

Cantwell and Mudambi (2005) investigate the relationship between the R&D responsibilities assigned to foreign subsidiaries, and the output mandates that such subsidiaries have received from their parents. In their sample of UK subsidiaries of non-UK MNEs, one thing that clearly stands out is the substantially larger RDI of subsidiaries with a competence creating mandate (CC), versus those with a competence exploiting (CE) mandate.[4] It should be noted that in their study a CC mandate refers to local subsidiary responsibilities for product development and international strategy development within their MNE group, and so is measured

[4] Specifically, in their Table 4(b) (p. 1120) they show an RDI (measured as a subsidiary's R&D over sales ratio) of 5.1% versus 2.9% of competence creating versus competence exploiting subsidiaries respectively.

independently of the R&D activities of a subsidiary. Moreover, their empirical tests also demonstrate that in addition to the observed quantitative difference in RDI between subsidiary types, there is also a qualitative difference in the motives for and hence in the nature of R&D undertaken. In particular, R&D assignments to CE subsidiaries are more sensitive to local demand conditions, whereas those of CC subsidiaries respond more to the level of regional development, resources, infrastructure and science base in the host location, a result which is further corroborated in Cantwell and Piscitello (2005; 2007).

Marin and Bell (2007) study the productivity effects of foreign subsidiaries located in Argentina in the period 1992-1996. To examine these effects, they propose *inter alia* an "active subsidiary model", in which knowledge spillovers to domestic firms arise only if subsidiaries are technologically active. Their empirical results provide strong support for this model, implying that knowledge spillovers from foreign subsidiaries mainly arise as a result of their own local competence creating and technology seeking activities.

Furthermore, a recent study by Phene and Almeida (2008) on foreign subsidiaries of US MNEs in the semiconductor industry adds to this result, as these authors demonstrate that subsidiaries with higher technology sourcing capabilities also engage in larger scale innovative efforts. In addition, their study finds consistent evidence of the importance of knowledge obtained from host country firms in stimulating subsidiary innovation. This would actually suggest a positive feedback effect, whereby CC subsidiaries obtain more R&D responsibilities, as a result they are able to source more knowledge from host country firms, and in turn they become even more innovative.

What all these studies clearly demonstrate is that the RDI of foreign subsidiaries with a technology seeking (or competence creating) mandate is not at all obviously lower than that of the host country firms active in the sector in which the subsidiaries are operating. The study of Cantwell and Mudambi (2005) also demonstrates that in comparison with CE subsidiaries, CC subsidiaries have a clearly larger RDI. As a consequence, technology seeking FDI is likely to generate positive productivity effects in its host-country environment. Additionally, given its greater RDI, such productivity effects are likely to be at least as large as, or even larger than those of technology exploiting FDI.

Firm heterogeneity and technology seeking FDI

A substantial amount of research has either implicitly or explicitly considered the nature or characteristics of the firms that engage in technology seeking FDI. In particular, the question of whether high-productivity (leader) or low-productivity (laggard) firms engage in this type of FDI has featured prominently in this debate. Many of the earlier empirical industry-level studies had suggested that laggards are more likely to engage in technology seeking FDI, as they stand to gain the most from it (Kogut and Chang, 1991; Hennart and Park, 1993; Neven and Siotis, 1996). This conclusion has also been formalized (Fosfuri and Motta, 1999; Siotis, 1999).

However, more recent microeconomic evidence suggests quite the contrary. Notably, in a study of Japanese investors in the United States, Berry (2006) convincingly demonstrates that leaders are more likely to engage in technology seeking FDI, a result which is corroborated *inter alia* by Le Bas and Sierra (2002), Branstetter (2006) and Griffith, Harrison and van Reenen (2006). Berry (2006) explains this finding by arguing that unlike leaders, laggard firms have neither the absorptive capacity nor the intra-firm technology transfer skills necessary to benefit from technology seeking FDI. Formalizing these arguments, Smeets and Bosker (2008) also demonstrate the likelihood of leaders engaging in technology seeking FDI, and provide an empirical illustration of this.

The implication of these more recent and more detailed studies on firm heterogeneity and FDI motives is that leaders, and not laggards, are more likely to engage in technology seeking FDI. Consequently, the implication is that in terms of spillover or diffusion potential, technology seeking FDI can be expected to generate at least as intense a level of productivity spillover effects in its host-country environment as does technology exploiting FDI.

The reciprocal nature of knowledge diffusion

A third reason to expect that technology seeking subsidiaries are as least as conducive to positive productivity effects as technology exploiting subsidiaries has to do with the alleged reciprocal nature of knowledge diffusion.

Already in 1989, Cantwell argued that in order to benefit from knowledge feedbacks, MNEs’ subsidiaries have to internalize foreign technology development, which implies that their own operations have to be firmly embedded in the host-country environment. This in turn will generate larger knowledge diffusion potential from the subsidiaries to the host-country firms. As such, two-way knowledge diffusion is essentially just part of the logic of MNE expansion (Cantwell, 1989).

Frost (2001) makes a similar argument which he also formulates from an embeddedness perspective. He argues that the norm of reciprocity requires sufficient contributory innovative capacity on behalf of firms which themselves whish to capture external knowledge. Specifically, he claims that "subsidiaries with greater innovation scale may be more likely to access and utilize local sources of knowledge during the innovation process" (2001: 107). His empirical analysis of patent citations by a sample of US-based subsidiaries of foreign MNEs during the period 1980-1990 provides broad empirical support for this conjecture.

In a study of FDI in China, Wei, Liu and Wang (2008) substantiate this finding. Utilizing a 3SLS model to simultaneously investigate the knowledge diffusion effect from FDI to the host economy and vice versa, they find very strong and robust evidence of mutual (i.e. two-way) knowledge diffusion effects. This result again implies that when successful in technology seeking, subsidiaries are most likely to also diffuse some knowledge of their own. Similar findings are documented in Liu, Wang and Wei (2006).

These findings provide a third argument as to why technology seeking FDI may be at least as conducive to knowledge diffusion as technology exploiting FDI: It appears that in order for a subsidiary to benefit from knowledge spillovers generated by domestic firms – and as such perform its technology seeking task – it also needs to contribute to its local environment in terms of knowledge diffusion itself.

Technology seeking FDI and market orientation

A fourth and final reason to expect a positive productivity effect from technology seeking FDI has to do with the competition effects it generates. Cantwell and Mudambi (2005) operationalize the technology seeking mandate of a subsidiary to encompass both product development and international strategy development. This implies that the expected competition effects these types of subsidiaries generate on their local environment are limited, due to the general absence of a local-market serving mandate.

Indeed, Girma, Görg and Pisu (2008) empirically demonstrate that only FDI with a local market-orientation generates adverse competition effects on its local competitors, whereas FDI with a more outward or export-orientation does not. As the orientation of technology seeking subsidiaries is likely to be more outward – either to other MNE subsidiaries in third countries, or to the parent company in the home country – its competition effects will at least be smaller than those of local-market oriented technology exploiting FDI. The way in which we operationalize technology seeking FDI (see next section) further contributes to this mechanism.

Summarizing, based on previous literature we have developed four arguments to support our claim of positive productivity effects of technology seeking FDI: The RDI of this type of FDI has been demonstrated to be substantial; recent microeconomic evidence indicates that high-productivity leader firms are more likely to engage in this type of FDI; the demonstrated reciprocal nature of knowledge diffusion implies that technology seeking FDI is only successful when it also contributes to the productivity of its local environment; and the adverse competition effects generated by technology seeking FDI are expected to be limited.

We would like to note explicitly however, that we do not argue here that technology exploiting FDI does not generate productivity effects in the host country: Since this type of FDI by definition exploits a competitive (technology) asset of the MNE, there is at least a potential for knowledge diffusion. Moreover, given that it will also be integrated in the local economy in terms of supplier and customer networks, there are also sufficient diffusion mechanisms present for this type of FDI. However, based on the foregoing we expect technology seeking FDI to generate productivity effects that are at least as large as those of technology exploiting FDI.

Thus, we end up with the following two hypotheses, that we will investigate empirically in the remainder of this paper:

Hypothesis 1: Technology exploiting FDI will have positive host country productivity effects.

Hypothesis 2: Technology seeking FDI will have positive host country productivity effects that are at least as large as those of technology exploiting FDI.

DATA & METHODOLOGY

In the empirical part of this paper we will try to illustrate our argument using industry level data of subsidiary activities of US MNEs in 14 OECD countries over the period 1987-2003.[5] In doing so, we try to improve upon the analyses of Girma (2005) and Driffield and Love (2007) in a number of ways.

First and foremost, we are able to distinguish US MNEs' subsidiary activities according to (i) their market orientation and (ii) the extent to which they are integrated into the MNE's intra-firm network. As we will explain in detail below, this enables us to proxy for *general* exploiting versus seeking motives of FDI. Second, utilizing data on technology license payments from US parents to their foreign affiliates, and making use of the industry-level nature of the dataset, we are able to construct a measure of *technology* exploiting and seeking FDI, which does not rely on the relative (home-host) RDIs as in Girma (2005) and Driffield and Love (2007). Third, in line with studies by Wei and Liu (2006) and Wei et al. (2008), we use both affiliate capital stocks and affiliate employment levels as two different measures of MNE presence, in order to explore the different diffusion channels that may be present, as well as to test the robustness of our results. We elaborate on all these contributions below.

FDI motives and market orientation

We use industry-level data from the Bureau of Economic Analysis (BEA) in order to measure the activities of foreign affiliates of US MNEs. The BEA provides data regarding the operations of foreign subsidiaries on *inter alia* the amount of their annual sales, their net fixed capital stocks, the number of persons employed, and MNE R&D expenditures.

As explained above, Girma (2005) and Driffield and Love (2007) distinguish between technology seeking and exploiting FDI by comparing *inter alia* relative home-host RDIs. Specifically, they coin FDI in sectors with relative RDIs < 1 as technology seeking FDI, and that in sectors with relative RDIs > 1 as technology exploiting. However, such a distinction relies on the assumption that *laggards* engage in technology seeking FDI, whereas *leaders* engage in technology exploiting FDI. But the arguments developed in the previous section point out that this is a misleading point of departure, as highly innovative and productive (leader) firms engage *both* in technology exploiting and seeking FDI. In other words, relative RDIs might serve as a

[5] The Appendix contains a full list of countries and industries included in the analysis.

proxy to distinguish leaders from laggards, but they cannot discriminate between the two different investment motives.

Therefore, we propose a different construct to capture the two different FDI motives. First of all, based on Cantwell and Mudambi (2005) who assign a CC mandate to subsidiaries if the functional scope of its output mandate includes either product development or international strategy development, we consider the outward orientation (or the lack of an explicit local-market orientation) of subsidiaries' activities as a crucial determinant of their technology seeking mandate. Specifically, the BEA data allow us to split up foreign affiliate sales into sales destined for the local market *versus* sales destined for exports (from the host country). We compute the relative shares of these two types of sales, and relate the share of local sales to technology exploiting motives, and the share of export sales to technology seeking motives. That is:

(1) $$\text{exploiting FDI}_{\text{ijt}} = \frac{\text{local sales}_{\text{ijt}}}{\text{total sales}_{\text{ijt}}} \times FDI_{ijt}$$

where *i*, *j* and *t* index industry, country and time respectively, and *FDI* is a measure of MNE presence (we use subsidiary capital stocks as the main variable and subsidiary employment for a robustness check). Similarly, for *seeking FDI*:

(2) $$\text{seeking FDI}_{\text{ijt}} = \frac{\text{exports to other countries}_{\text{ijt}}}{\text{total sales}_{\text{ijt}}} \times FDI_{ijt}$$

Another way of looking at these proxies is by considering the literature on market seeking and efficiency seeking FDI (Beugelsdijk, Smeets and Zwinkels, 2008). Market seeking FDI is aimed at generating sales in the host country market (i.e. *exploiting FDI*) and as such has a large technology exploiting component. Efficiency or resource seeking FDI on the other hand is aimed at globally splitting up the value chain and relocating the various activities in the places where they can be undertaken most efficiently, or where there are appropriate resources available. Given that this type of FDI generates a large amount of complementary (intra-firm) trade, it has often been associated with our operationalization of *seeking FDI* (Beugelsdijk et al., 2008).

However, since our host country sample contains only developed (OECD) countries, the efficiencies or resources that US MNEs are seeking in this context may very well be related to technology. That is, in the present context our measure of *seeking FDI* may very well be a proxy of *technology* seeking FDI. In order to illustrate this argument, consider the first column in Table 1 below: It shows the relative shares for *seeking FDI* in each sector, where the latter are ordered from high-tech (upper row) to low-tech (lower row), based on the OECD classification.[6]

<< INSERT TABLE 1 ABOUT HERE >>

What becomes immediately clear from the table is that the share of *seeking FDI* is more or less equal to (or sometimes even larger than) 50% of the total in high-tech industries, whereas in the low-tech industries *seeking FDI* is clearly the minority type. This further illustrates our conjecture that *seeking FDI* is likely to be at least partly related to technology seeking FDI.

A potential objection to our interpretation of *seeking FDI* as being a proxy for being technology seeking FDI, is indeed that it might just as well be seeking general efficiency advantages other than those related to technology. Therefore, we complement this taxonomy along two dimensions.[7] First of all, utilizing subsidiary-level data on technology license payments received by foreign affiliates from their US parents, we are able to measure the extent to which a subsidiary is responsible for generating or creating new (to the firm as a whole) knowledge or technology. Specifically, if such payments are positive, we assume that a subsidiary has engaged in some degree of competence creating or technology seeking activities. Moreover, if these positive payments are combined with *seeking FDI*, we call it technology seeking FDI. If technology payments are zero but FDI is still of the *seeking* type, we consider

[6] The ordering of the industries in the table also corresponds to the median industry RDI (R&D expenditures over value added) from high (computers & electronic industries) to low (utilities). We choose the median RDI instead of the mean RDI because of some outliers in the distribution.

[7] Or, following Driffield and Love (2007), it could be argued that the orientation of FDI is just related to the distinction between market-seeking and efficiency-seeking, and we need the additional characteristics discussed hereafter to dissect the latter into efficiency seeking vis-à-vis technology seeking FDI.

it as more general efficiency seeking FDI. In the case of *exploiting FDI*, it is predominantly of the (technology) exploiting kind, regardless of the amount of technology license payments.

Second, we also consider a distinction between high and medium-tech sectors on the one hand, and low-tech sectors on the other hand in order to be able to relate the type of FDI to technology intensity (or similarly, to industries with high versus low RDIs, cf. footnote 6). Specifically, if the type of FDI is *seeking FDI* and takes place in high and medium tech industries, it will be predominantly of the technology seeking type, whereas if it occurs in low-tech industries, it will be searching for more general efficiencies. If the type is *exploiting FDI*, it will be predominantly exploiting FDI in all industry types.

In the light of the foregoing, we believe that our proxies for seeking FDI in combination with these taxonomies are preferable to those of Grünfeld (2005) and Driffield and Love (2007), based on relative RDIs. However, in order to enhance comparability between our results and theirs, we also compute RRDIs in order to be able to apply their classiffication. RRDIs are calculated as:

$$(3) \qquad RRDI_{ijt} = \frac{(MNE\_R\&DStock_{ijt} / MNE\_CapitalStock_{ijt})}{(R\&DStock_{ijt} / CapitalStock_{ijt})}$$

where i, j, and t index industry, country and time respectively. Hence, *RRDI* is the ratio of the R&D intensity of US MNEs active in industry i, (host) country j and time t, over the R&D intensity of that host country's industry j at time t.[8] This improves upon Girma (2005) and Driffield and Love (2007), who use industry-level R&D intensities of the home country of the MNE as the numerator of *RRDI*. Following their line of argumentation, we classify both *exploiting FDI* and *seeking FDI* with an *RRDI* > 1 (< 1) as technology exploiting FDI (technology seeking FDI). Table 2 below summarizes this discussion, and presents the resulting taxonomy between technology exploiting and seeking FDI.

<< INSERT TABLE 2 ABOUT HERE >>

[8] We use capital stocks rather than value added or output as the denominator in both RDIs, since this is the only variable for which we have observations for both MNEs as well as industries.

One final objection that could be raised regarding our use of *seeking FDI* as a proxy for technology seeking FDI, is that it is not outward orientation persé that matters, but rather outward orientation towards other affiliated partners, i.e. the parent firm and/or other foreign affiliates. That is, if the subsidiary indeed has a technology seeking mandate, we would expect it to be sufficiently integrated in the MNE's global intra-firm network.

Unfortunately, the BEA data at the industry-level do not allow us to track exports to other MNE affiliates in third countries. However, they do allow us to measure the exports from the subsidiary back to its US parent. We can thus split up *seeking FDI* into intra-firm exports back to the US parent, and exports to (affiliated and unaffiliated) parties in other countries. If we coin the former as *home seeking FDI* and the latter as *other seeking FDI*, we are thus able to split up *seeking FDI* into:

$$\text{home seeking FDI}_{\text{ijt}} = \frac{\text{exports to US parent}_{\text{ijt}}}{\text{total sales}_{\text{ijt}}} \times FDI_{ijt}$$

(4)

$$\text{other seeking FDI}_{\text{ijt}} = \frac{\text{exports to third countries}_{\text{ijt}}}{\text{total sales}_{\text{ijt}}} \times FDI_{ijt}$$

If, next to the outward orientation, we also require a sufficient degree of intra-firm integration to consider FDI as technology seeking, *home seeking FDI* may be more suited in this respect than *other seeking FDI*.[9] *Other seeking FDI* in turn may be regarded as export platform FDI (Ekholm, Forslid and Markusen, 2007). The second and third column in Table 1 report *home seeking FDI* and *other seeking FDI* as a share of *seeking FDI*. Although the relative shares of *home seeking FDI* are much smaller than the combined shares in column 1, the overall inter-industry pattern in columns (2) and (3) is very similar to that in column (1). Below we will also investigate this additional distinction empirically.[10]

[9] At the aggregate (country) level, it is possible to distinguish between exports to affiliated *vis-à-vis* unaffiliated parties in *other seeking FDI*. For our sample and time-period, the figures show that approximately 22% of these exports are intra-firm, which further supports using *home seeking FDI* as an indicator of intra-firm integration.
[10] We loose some observations as industry-level data on *home seeking FDI* are only available from 1989 onward.

Model variables

The model we wish to estimate takes the following form (with lower case letters denoting logs):

$$(5) \qquad y_{ijt} = \beta_0 + \beta_1 l_{ijt} + \beta_2 k_{ijt} + \boldsymbol{\beta}_{\mathbf{4}} \mathbf{FDI}_{\mathbf{ijt}} + \boldsymbol{\beta}_{\mathbf{5}} \mathbf{X}_{\mathbf{ijt}} + D_i + D_j + D_t + \varepsilon_{ijt}$$

where *i*, *j* and *t* index country, industry and time respectively, *y* is value added, *l* is employment, measured as total hours worked, *k* is the capital stock, **FDI** is a vector with our different types of FDI, **X** is a vector of control variables, the *D*'s denote fixed effects and *ε* is an error term. The parameters of interest are contained in the vector β_4 and measure the effect of (different types of) FDI on industry productivity.

The data for *y* and *k* are obtained from the OECD STAN database, and the data on *l* from the Groningen Growth and Development Center (GGDC). Value added and capital stocks are measured in million of US dollars, and the latter are computed from data on capital expenditures using the perpetual inventory method and imposing a generic annual depreciation rate of 5% (Hall and Mairesse, 1995). Employment is measured in thousands of total hours worked.

We use two control variables in the vector **X**: (the log of) industry-level exports, measured in million of US dollars and also taken from the STAN database (*Exports*), and (the log of) industry-level R&D stocks, computed from data on R&D expenditures (from the OECD ANBERD database – *R&D*) using the perpetual inventory method and imposing a generic annual depreciation rate of 15% (Hall and Mairesse, 1995). Since industry-level exports also contain the exports of the US MNEs in our sample that we use in constructing the different FDI types, we net out those exports from the industry aggregate.

The **FDI** vector contains both *exploiting FDI* and *seeking FDI* (and later on also *home seeking FDI* and *other seeking FDI*) as defined above. In order to do justice to the taxonomy as shown in Table 2, the model in (5) is not only analyzed for our total sample, but also for different subsamples that correspond to the different taxonomies implied by the rows in Table 2. Data on technology license payments and US MNE R&D stocks were also taken from the BEA and measured in millions of US dollars. R&D stocks were again computed from R&D expenditures, similar to the method for industry-level R&D.

As mentioned above, our sample covers 14 OECD host countries and 8 manufacturing industries over the period 1987-2003. However, the panel is very unbalanced due to missing observations for many countries. Moreover, data on technology license payments were only available from 1994 onward, so that those parts of the analyses using this variable use a limited sample. All variables have been deflated using industry-level GDP deflators.[11] When appropriate, variables measured in foreign currencies (in case of OECD data) have been transformed into US dollars using PPP exchange rates. Table 3 below presents some summary statistics and correlations for the variables in our model.

<< INSERT TABLE 3 ABOUT HERE >>

Methodology

In the empirical FDI knowledge diffusion literature, the potential endogeneity of FDI is a well-known problem: If foreign investors set up their subsidiaries in more productive countries, sectors or regions, any inferred productivity effects from FDI in model (5) will be spurious.

Reverting to IV regression analysis would provide a way out of this situation (Beugelsdijk et al. 2008), but such an approach is not straightforward in the present context: Even though the gravity literature provides a number of potentially exogenous instruments for FDI, these mainly function at the country level rather than the industry level that we explore in this paper.

Under these circumstances, it is appropriate to use Generalized Method of Moments (GMM) estimation (Roodman, 2006). One specific estimator in this context is difference-GMM by Arrelano and Bond (1991). This estimator transforms the model into first differences[12] and uses lagged levels of the endogenous variables as its instruments. It also employs a feasible estimator of the variance-covariance matrix of the error term, thus correcting for heteroskedasticity and serial correlation.

Blundell and Bond (1998) extend this approach by introducing the system-GMM estimator. This estimator builds a system of equations in both levels and

[11] Although Kafouros and Buckley (2008) argue and demonstrate that the use of common deflators is not appropriate when dealing with R&D expenditures, we are not aware of more specific deflators for these countries and sectors on the scale used in our sample. As such, we use GDP deflators for R&D as well.

[12] In the differenced equation, time-invariant variables in model (5) such as country and sector fixed effects are no longer present.

differences. The instrument set consists of lagged differences for the level equation, and lagged levels for the difference equation. It allows for inclusion of time-invariant regressors and corrects for heteroskedasticity and serial correlation (Roodman, 2006).

Although difference-GMM and system-GMM are usually applied in dynamic panels (with a lagged dependent variable as a regressor), it can also be applied in models without a lagged dependent variable, such as the one in (5), as a more general versions of the IV estimator. We will adopt the system-GMM estimator by Blundell and Bond (1998) as it exploits more information in the data than the difference-GMM estimator.

Given the relatively limited amount of observations in our sample (N = 645 in the largest sample), we are forced to restrict the number of lags used in the GMM difference equation, since otherwise the number of instruments in the estimation becomes too large relative to the number of observations, resulting in overfitting of the model (Roodman, 2006). We follow Driffield and Love (2007) and impose a maximum lag structure of 4 years. Moreover, as Madariaga and Poncet (2007) argue, although the two-step estimator is more efficient, it is only appropriate in relatively large samples as otherwise it heavily biases the coefficient estimates. Therefore, we employ the one-step estimator. We also utilize the small sample correction proposed by Roodman (2006), and report robust standard errors in the tables that follow.

EMPIRICAL RESULTS

Table 4 presents the results of the empirical model in (5), combined with the taxonomies proposed in Table 2. The measure of MNE presence used in this table (and Table 5) is net fixed capital stocks of the foreign affiliates. The first column estimates the model for the full sample. The coefficients on *labor*, *capital* and *exports* are all according to expectation, significant and sensible in magnitude. However, the coefficient on *R&D* takes an unexpected negative sign, but it is not statistically significant. The coefficient on *exploiting FDI* is positive and significant, indicating positive productivity effects of this type of FDI, which is in accordance with Hypothesis 1. However, *seeking FDI* is positive but insignificant, which is not in accordance with Hypothesis 2. Yet, given the taxonomies proposed in Table 2, this variable may now be capturing both technology seeking as well as more general efficiency seeking FDI. In order to make a more finely grained distinction between these two, the other columns in the table split up the sample in accordance with the classifications in Table 2.

<< INSERT TABLE 4 ABOUT HERE >>

Columns 2 and 3 in Table 4 split up the sample according to whether or not a foreign affiliate has received any technology license payments from the parent company. Column 2 considers those cases in which there were positive payments, whereas column 3 considers those where there were no payments whatsoever. In this case a clear difference arises between the two subsamples: Only for the subsample in which there are positive technology payments does *seeking FDI* have a positive and significant effect. If there are no such payments, there are no effects. *Exploiting FDI* is positive and significant in both samples. Additionally, its coefficient estimate in column 2 is smaller than that of *seeking FDI*. Hence, these results support both Hypotheses 1 and 2.

The taxonomy in columns 4 and 5 corroborates this finding. Here the sample is split up between high-tech and low-tech industries (high-tech including the high and medium-tech industries of Table 2). Again we find that in the high-tech sample, where *seeking FDI* is predominantly of the technology seeking type, it has a positive productivity effect. Again, its coefficient estimate is larger than that of *exploiting FDI*, which itself again is positive and significant in both samples.

Columns 6 and 7 split up the sample into those observations with a *RRDI* (from equation (3)) smaller and bigger than 1 respectively, in accordance with the approach undertaken by Girma (2005) and Driffield and Love (2007). As can be seen, in both columns *exploiting FDI* and *seeking FDI* are now significant and positive, indicating the positive productivity effects of both technology seeking (column 6) *and* exploiting FDI (column 7), again confirming both Hypothesis 1 and 2, but in stark contrast to the results of Girma (2005) and Driffield and Love (2007).

As suggested in the data section, just looking at the presence or absence of any outward orientation in FDI may not capture an additional relevant aspect of technology (or efficiency) seeking FDI, which is the extent to which it is integrated into the intra-firm MNE network. Therefore, in the following we split up *seeking FDI* into *home seeking FDI* and *other seeking FDI*, the former of which explicitly takes into account the affiliates intra-firm integration. The results are reported in Table 5 below.

<< INSERT TABLE 5 ABOUT HERE >>

For *exploiting FDI*, the general picture that emerges from Table 5 is very similar to that in Table 4: *Exploiting FDI* has a consistent positive productivity effect in all of the models, in accordance with Hypothesis 1.

Recall from the previous section that due to the fact that it reflects integration into the MNE's internal network, *home seeking FDI* is arguably a better proxy for technology seeking FDI (and, for that matter, efficiency seeking FDI) than *seeking FDI* in general. With this in mind, we observe a consistently positive and significant effect of *home seeking FDI* in those subsamples for which it proxies technology seeking FDI (columns 2, 4, and 6). Moreover, the coefficient estimate is also consistently larger than that for *exploiting FDI* in those columns. As such, these results provide strong support for Hypothesis 2.

Additionally, in those cases where *home seeking FDI* captures either the more general efficiency seeking FDI (columns 3 and 5) or *technology exploiting FDI* following Girma (2005) and Driffield and Love (2007) (column 7), it as also positive and significant, save for one instance (column 5). This indicates that the more general efficiency seeking FDI, when more accurately proxied by *home seeking FDI*, also generates positive and significant productivity effects. This result also more clearly demonstrates the divergence between *seeking FDI* and *home seeking FDI* as two different proxies, as the former never yields significant effects when proxying efficiency seeking FDI in Table 4.

Finally, regarding *other seeking FDI*, results are somewhat mixed, with the variable showing generally positive and significant effects in the technology seeking subsamples, but not in the efficiency seeking subsamples. The exception are the final two columns, where *other seeking FDI* is positive and significant in both instances, again indicating that both technology seeking and exploiting FDI generate positive productivity effects.

Alternative measure of MNE presence

In their meta-study of empirical FDI knowledge spillover studies, Görg and Strobl (2001) find that the measure of MNE presence used has an important effect on whether or not productivity effects are found. Wei and Liu (2006) and Wei et al. (2008) combine this finding with a theoretical argument: They relate different measures of MNE presence to different knowledge diffusion mechanisms. Specifically, measuring MNE presence through capital stocks (as in Tables 4 and 5) will be good a proxy for diffusion through demonstration effects, whereas measuring it in terms of employment will generally be a proxy for diffusion through labor turnover. Given this potential importance of using different FDI measures, we repeat the analysis while using subsidiary employment levels as our measure of MNE presence. Table 6 presents the results. For reasons of space we only report the coefficient estimates of the FDI variables.

Regarding the effect of *exploiting FDI* we observe that it generally retains its positive productivity effects, except for columns (2) and (3). The results for *home seeking FDI* stand up to the test more firmly, as the results completely correspond to those in Table 5. *Other seeking FDI*, finally, appears to loose much of its earlier effects. Apparently, its productivity effects work mainly through demonstration effects and not through labor turnover. Alternatively, we could say that *exploiting FDI* and *home seeking FDI* are largely robust to a change in the measure of MNE presence, whereas *other seeking FDI* is not.

<< INSERT TABLE 6 ABOUT HERE >>

CONLCUSION

In this paper we have proposed that both technology exploiting as well as technology seeking FDI generate positive productivity effects on their local host-country environment. For technology exploiting FDI this observation is fairly well-established, since by definition it carries and exploits some competitive (technology) asset of the firm in the host-country, which in turn might diffuse to domestic firms. Yet for technology seeking FDI this claim is more controversial, as recent studies have argued and demonstrated that this type of FDI will not induce any productivity effects (Girma, 2005; Driffield and Love, 2007).

We base our claim of positive productivity effects of technology seeking FDI on four arguments: First, a number of recent empirical microeconomic studies have demonstrated that the R&D and innovation intensity of MNE subsidiaries with a technology seeking mandate is substantial, and even likely to outperform that of technology exploiting subsidiaries. Second, there is increasing theoretical and empirical evidence that productivity leaders rather than laggards engage in technology seeking FDI, implying high knowledge spillover potential. Third, it has been demonstrated that productivity spillovers are most likely to be mutual, flowing not only from the MNE to domestic firms but also the other way around. This implies that to successfully seek technology, subsidiaries also have to be prepared to diffuse some of their own. Fourth and finally, adverse competition effects of technology seeking FDI can be expected to be lower than those of technology exploiting FDI, thus resulting in a more positive overall productivity effect.

Based on these four arguments we hypothesize positive productivity effects of technology exploiting and seeking FDI, arguing further that the effects of the latter will be larger than those of the former. Using data on US MNEs' foreign activities in 14 OECD countries and 8 industries over the period 1987-2003, we find strong and consistent support for both these hypotheses: Both types of FDI generate positive productivity effects, and the coefficient estimates of technology seeking FDI are consistently larger than those of technology exploiting FDI. Moreover, the positive effects of technology exploiting and seeking FDI are also robust to a change in the measure of MNE presence.

One clear limitation of the present study is its reliance on (rather aggregate) industry-level data, and the implication that we need proxies for FDI with technology exploiting and seeking motives, rather than more factual indicators (cf. Cantwell and Mudambi, 2005). Additional research using firm-level data which investigates the productivity effects of the two different FDI types would therefore be highly useful. Given that many previous studies have already investigated many other aspects of these types of FDI at the firm-level, this should be a manageable avenue of future research.

Another limitation is the fact that our sample of host-countries is limited to OECD countries only. This is caused by the fact that detailed industry-level information on the dependent and explanatory (control) variables in our model are hard to come by for developing countries. However, it might be expected that the types of FDI differ substantially for developed *versus* developing countries, not only between exploiting vis-à-vis seeking FDI, but also within seeking FDI (efficiency seeking *versus* technology seeking). Including developing countries in the sample could substantially add to the variation in the FDI types and as such to the identification of the parameters in our model.

As a final note, we would like to stress that using relative R&D intensities (RDIs) as constructs to capture FDI motives as in Girma (2005) and Driffield and Love (2007), we actually find consistently find that both technology exploiting and seeking FDI generate positive productivity effects. However, given the arguments presented in Section 2, we believe that relative RDIs are not able to properly differentiate between these two FDI motives. Instead, we have provided two alternative – and in our view preferable – taxonomies, based on technology license payments to subsidiaries and industry-classifications, the results of which all corroborate our hypotheses. We are therefore confident in claiming that we have indeed shown that technology seeking FDI generates positive productivity effects to its host-country environment.

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Table 1: Sectoral distribution of FDI types (N = 568)

Tech Intensity	Sector	Seeking FDI	*Of which*	
			Home seeking FDI	Other seeking FDI
High Tech	Computers & electronic products	0.47	0.08	0.40
Medium Tech	Chemicals	0.45	0.05	0.40
	Transportation equipment	0.45	0.09	0.36
	Electrical equipment, appliances & components	0.38	0.06	0.34
	Machinery	0.51	0.08	0.43
Low Tech	Primary & fabricated metals	0.37	0.03	0.33
	Food & kindred products	0.25	0.01	0.23
	Utilities	0.00	0.00	0.00

Table 2: FDI taxonomies

Indicator		**Exploiting FDI**	**Seeking FDI**
Technology License Payments	> 0	Technology exploiting FDI	Technology seeking FDI
	= 0		Efficiency seeking FDI
Industry Classification	High and medium-tech		Technology seeking FDI
	Low-tech		Efficiency seeking FDI
Home-Host RDI (Girma, 2005; Driffield and Love, 2007)	> 1	Technology exploiting FDI	Technology exploiting FDI
	< 1	Technology seeking FDI	Technology seeking FDI

Table 3: Descriptive statistics and pairwise correlations (N = 568)

	1.	2.	3.	4.	5.	6.	7.	8.	9.
1. Value added[a]	1.00								
2. Labor[a]	0.91	1.00							
3. Capital[a]	0.83	0.76	1.00						
4. R&D[a]	0.56	0.54	0.49	1.00					
5. Exports[a]	0.58	0.57	0.48	0.61	1.00				
6. Exploiting FDI	0.48	0.49	0.38	0.33	0.12	1.00			
7. Seeking FDI	-0.04	-0.10	-0.10	0.22	0.19	-0.40	1.00		
8. Home seeking FDI	-0.04	-0.09	-0.09	-0.03	-0.09	-0.03	0.34	1.00	
9. Other seeking FDI	0.01	-0.06	-0.06	0.24	0.24	-0.41	0.85	-0.29	1.00
Mean	9.30	5.19	10.3	8.08	9.21	3.48	2.71	0.37	2.19
s.d.	1.15	1.13	1.90	1.56	1.55	1.71	1.58	0.71	1.53

Table 4: Exploiting FDI, seeking FDI and knowledge diffusion

	(1) Total Sample	(2) Tech License Pay > 0	(3) Tech License Pay = 0	(4) High-Tech Industries	(5) Low-Tech industries	(6) RRDI<=1	(7) RRDI >1
Employment	0.622**	0.637**	0.560**	0.566**	0.561**	0.492**	0.608**
	(.071)	(.071)	(.106)	(.062)	(0.133)	(.078)	(.059)
Capital	0.125**	0.180**	0.178*	0.164**	0.147†	0.359**	0.070*
	(.037)	(.049)	(.072)	(.034)	(.087)	(.059)	(.034)
R&D Stock	-0.013	-0.082	0.021	0.009	0.037	-0.084	-0.063
	(.049)	(.059)	(.083)	(.045)	(.086)	(.075)	(.069)
Exports	0.121†	0.079†	0.025	0.108**	0.037	0.224**	0.189**
	(.063)	(.043)	(.061)	(.029)	(.057)	(.061)	(.064)
Exploiting FDI	0.114*	0.144**	0.114*	0.097**	0.115**	0.108*	0.158**
	(.045)	(.053)	(.048)	(.036)	(.039)	(.050)	(.038)
Seeking FDI	0.096	0.163*	0.066	0.146*	-0.060	0.129*	0.168*
	(.071)	(.068)	(.091)	(.046)	(.082)	(.048)	(.067)
Constant	2.92**	3.66**	4.19**	2.63**	3.61**	2.24**	3.55**
	(.402)	(.453)	(.622)	(.280)	(.816)	(.420)	(.368)
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-stat	48.4**	36.1**	26.4**	92.9**	41.0**	805.4**	250.9**
Hansen-test	52.5	31.8	26.5	23.8	6.44	7.28	25.6
AR1	0.50	0.65	0.69	0.09	-0.49	-0.14	-1.43
N	645	190	134	427	218	122	357

Notes: Dependent variables is (Log) Value Added

System GMM-estimates – One step robust estimator, lags 2-4 used for endogenous variables (i.e. all variables)

** 1% sig; * 5% sig; † 10% sig.

Table 5: Disentangling Seeking FDI

	(1) Total Sample	(2) Tech License Pay > 0	(3) Tech License Pay = 0	(4) High-Tech Industries	(5) Low-Tech industries	(6) RRDI<=1	(7) RRDI >1
Employment	0.606**	0.654**	0.623**	0.565**	0.527**	0.505**	0.611**
	(.068)	(.070)	(.080)	(.060)	(.146)	(.076)	(.057)
Capital	0.150**	0.183**	0.168*	0.154**	0.139†	0.353**	0.071†
	(.040)	(.055)	(.066)	(.032)	(.082)	(.053)	(.036)
R&D Stock	-0.018	-0.074	0.019	-0.010	0.038	-0.107	-0.054
	(.048)	(.062)	(.071)	(.048)	(.084)	(.075)	(.064)
Exports	0.075	0.071†	0.004	0.135**	0.048	0.251**	0.201*
	(.047)	(.041)	(.055)	(.040)	(.058)	(.057)	(.076)
Exploiting FDI	0.119**	0.158*	0.092†	0.123**	0.140**	0.123**	0.159**
	(.043)	(.061)	(.048)	(.038)	(.047)	(.040)	(.035)
Home seeking FDI	0.169*	0.227**	0.547*	0.226**	-0.370	0.248*	0.209**
	(.070)	(.080)	(.243)	(.073)	(.246)	(.092)	(.071)
Other seeking FDI	0.122†	0.173*	0.026	0.155**	-0.039	0.147**	0.158*
	(.063)	(.079)	(.053)	(.057)	(.084)	(.047)	(.067)
Constant	3.78**	3.49**	4.26**	3.02**	4.54**	2.11**	3.34**
	(.483)	(.451)	(.648)	(.313)	(.773)	(.394)	(.371)
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-stat	35.1**	36.5**	40.2**	103.8**	24.3**	1226.5**	298.7**
Hansen-test	49.0	29.3	31.0	25.4	6.58	12.9	17.9
AR1	1.50	0.46	0.73	-0.43	-0.04	-0.93	-1.39
N	568	189	132	374	194	120	342

Notes: Dependent variables is (Log) Value Added
System GMM-estimates – One step robust estimator, lags 2-4 used for endogenous variables (i.e. all variables).
** 1% sig; * 5% sig; † 10% sig.

Table 6: Subsidiary employment as a measure of MNE presence

	(1) Total Sample	(2) Tech License Pay > 0	(3) Tech License Pay = 0	(4) High-Tech Industries	(5) Low-Tech industries	(7) RRDI<=1	(6) RRDI >1
Exploiting	0.145*	0.084	0.065	0.121*	0.161†	0.251**	0.169**
FDI	(.065)	(.076)	(.095)	(.058)	(.085)	(.075)	(.057)
Home	0.238*	0.219*	1.543*	0.325**	-0.633	0.326*	0.242*
seeking FDI	(.110)	(.099)	(.710)	(.111)	(.404)	(.141)	(.104)
Other	0.167	0.102	-0.002	0.209*	-0.209	0.296**	0.136
seeking FDI	(.115)	(.098)	(.089)	(.100)	(.198)	(.071)	(.110)
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-stat	42.7**	21.7**	43.2**	97.4**	28.2**	1664.3**	75.4**
Hansen-test	56.1	27.8	22.0	24.4	6.07	5.63	26.4
AR1	1.22	-0.35	0.51	-0.40	0.15	-0.96	-1.39
N	570	188	134	375	195	120	341

Notes: Dependent variables is (Log) Value Added

System GMM-estimates – One step robust estimator, lags 2-4 used for endogenous variables (i.e. all variables).

** 1% sig; * 5% sig; † 10% sig.

Appendix

Table A.1: Sample countries & sectors

Countries	**Sectors**
Australia	Computers & electronic products
Belgium	Chemicals
Canada	Machinery
Denmark	Electrical equipment, appliances & components
Finland	Transportation equipment
France	Food & kindred products
Germany	Primary & fabricated metals
Ireland	Utilities
Italy	
Netherlands	
Norway	
Spain	
Sweden	
United Kingdom	