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Exporting, linkages and productivity spillovers from foreign direct investment

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Abstract

In this paper we analyse productivity spillovers from foreign direct investment using firm level panel data UK manufacturing industries from 1992 to 1999. We investigate spillovers through horizontal, backward and forward linkages, distinguish spillovers from export oriented vs domestic market oriented FDI, and allow for differing effects depending on domestic firms' export activities. The results suggest that the mechanisms through which spillovers affect domestic firms are very complex and that there are substantial differences in spillover benefits for domestic exporters and non-exporters, and from different types of inward investment.

Keywords: foreign direct investment, productivity spillovers, exporting, absorptive capacity, linkages, competition

JEL classification: F1, F2

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1 Introduction

Foreign direct investment (FDI) is often seen as an engine to economic growth and development, an assumption that has led many governments around the globe to try and attract multinationals by offering generous financial incentives. For example, the Government of the United Kingdom provided an estimated $30,000 and $50,000 per employee to attract Samsung and Siemens respectively to the North East of England in the late 1990s (Girma et al., 2001). One of the main rationales for these policy interventions is the belief that domestic firms can benefit from the presence of foreign multinationals through positive spillovers allowing them to improve their productivity. The argument, in a nutshell, is that foreign firms have a technological advantage vis-à-vis domestic firms and, hence, domestic firms can learn from them.

While this is easy to believe for developing countries, one may argue that there is less of an a priori reason why this should also hold true in developed economies. However, sticking with the example of the UK, recent studies show that foreign firms are more productive than the average domestic firm (e.g., Girma and Görg, 2007), and that in particular US multinationals are more productive than the headquarters of British firms that have operations abroad (Criscuolo and Martin, 2004). Therefore, there is a potential for spillovers from multinationals to domestic firms even in developed countries.

These spillovers can work through a number of channels. First, domestic firms can benefit from the presence of multinationals in the same industry, leading to intra-industry or *horizontal* spillovers, through the movement of workers within industries, demonstration effects, competition effects etc. Second, there may be spillovers from multinationals operating in other industries, leading to *vertical* spillovers. The latter type of external effect

is usually attributed to buyer-supplier linkages and therefore may be towards downstream industries (forward spillovers) and/or towards upstream industries (backward spillovers).[1]

While some case studies provide evidence suggestive of positive spillover effects (e.g., Moran 2001), the results from econometric analyses are mixed (e.g., Görg and Strobl, 2001). However, Girma et al. (2001), Haskel et al. (2002) and Keller and Yeaple (2003) are recent studies using firm level panel data, which find positive spillover effects for the UK and the US. As a counterbalance, a large number of studies such as Aitken and Harrison (1999) and Djankov and Hoekman (2000) for Venezuela and the Czech Republic, respectively, find negative spillovers in micro panel data.[2] The frequently given explanation for such negative effects is that multinationals compete with domestic firms and "steal business" from them. This forces domestic firms up their average cost curves and reduces measured productivity.

However, the literature to-date is subject to a number of shortcomings, which can perhaps also explain at least part of the failure of detecting any significant spillover effects on domestic firms. Firstly, most papers restrict themselves to attempting to detect *horizontal* spillovers by, say, relating the productivity (growth or level) of firm *i* in industry *j* to the presence of foreign multinationals in the same industry *j*, defined using the standard 2, 3 or 4 digit classification. This largely neglects the possibility of gains for domestic firms from *vertical* linkages with multinationals even though arguably some of these links will be between industries within the same 2 or 3 digit classification. However, the importance of more appropriately investigating vertical spillovers has been stressed by, for example, Keller (2001) and has been taken up in a number of recent papers: Driffield et al.

[1] See Blomström and Kokko (1998) for more detailed discussion of the channels for spillovers.
[2] Lipsey and Sjöholm (2005) argue that these mixed results can be explained as reflecting different firm and country characteristics in the different data sets used.

(2002), Blalock and Gertler (2003) and Javorcik (2004) argue and provide evidence that what may be more important are *vertical* rather than horizontal spillovers.

Secondly, in many studies the coefficient indicating spillovers is constrained to be the same for all firms, i.e., all domestic firms are assumed to benefit equally from FDI. This has been recognised in some recent work stressing the importance of domestic firms' absorptive capacity in order to benefit from spillovers (see, for example, Kokko et al. 1996, Kinoshita, 2001, Girma 2005). Arguably, it is also important when considering the negative business stealing effect, as different types of firms may be more or less likely to be in competition with multinationals. Thirdly, it is usually assumed that FDI is homogeneous and therefore that the potential spillover effect is the same for all types of FDI. However, as Moran (2001) shows in a number of case studies, multinational investment is quite heterogeneous with respect to its relationship with local firms, which can be assumed to have implications for any spillovers.[3]

In this paper we take all of these three issues into account using firm level panel data for UK manufacturing industries from 1992 to 1999. Firstly, we investigate the importance of both horizontal and vertical spillovers, where the latter are identified through backward and forward linkages from input-output tables.[4] Secondly, we allow the effect of spillovers to differ across domestic firms in two ways. We take into account firms' absorptive capacity similar to Girma (2005) but also distinguish effects of FDI on domestic exporters and non-exporters separately. The rationale for this distinction is the expectation that competition effects are different between these two types of firms and multinationals. Thirdly, we allow for the heterogeneity of FDI by distinguishing spillovers from primarily

[3] One way to describe this heterogeneity is by looking at the degree of ownership of foreign firms. For example, Javorcik and Spatareanu (2007) find that there are positive horizontal spillovers from fully-owned foreign affiliates but not from partially-owned affiliates in their firm level data for Romania. The opposite is true for vertical spillovers. We consider a different aspect of heterogeneity in this paper.

export oriented and domestic market oriented multinationals. Considering the export orientation of domestic and foreign firms goes some way towards distinguishing competition effects from pure knowledge spillovers. To the best of our knowledge, our paper is the first to take account of all of these three issues in a consistent way.

The remainder of the paper is organized as follows: the next section outlines the main sources of productivity spillovers from FDI. Section 3 discusses the methodology employed to detect such externalities. The description of the data set is in Section 4 while the estimation results are presented in Section 5. Finally, Section 6 provides a summary and conclusions.

2 Spillovers from FDI

The theoretical argument for why one may expect productivity spillovers from foreign multinationals is straightforward. Multinationals are expected to have access to some form of firm specific asset (FSA), such as a superior production technique, know-how, or management strategy, which has at least some of the characteristics of a public good and enables the firm to locate profitably abroad (Caves, 1996). These firm specific assets can be transferred at low or zero cost between subsidiaries of the same firm.

The possibility for positive spillovers arises because multinationals may find it difficult to protect a leakage of this FSA to other firms in the host country. The public good characteristics imply that once the FSA is out on the external market it can be used by other firms as well, due to it being at least to some extent non-rival and non-excludable. The inability of multinationals to protect the asset is due to labour mobility between firms (Fosfuri, Motta and Ronde 2001, Görg and Strobl, 2005), but also due to contacts between

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[4] Driffield et al. (2002) looks also at vertical spillovers but uses industry level data. Our firm level data are an

domestic suppliers or domestic customers and multinationals (Javorcik, 2004). These spillover channels have been described extensively in the recent literature, see, for example, Blomström and Kokko (1998).

As pointed out in the introduction, most of the literature to-date has focused on measuring *horizontal* spillovers, i.e., the beneficial effects from multinationals on domestic firms operating in the same industry (e.g., Aitken and Harrison, 1999; Blomström and Sjöholm, 1999; Keller and Yeaple, 2003). However, the knowledge transfers between domestic suppliers or customers and multinationals cannot, or only to a very limited degree, be captured by horizontal contacts alone, as there are *vertical* backward and forward relationships between firms in different industries. Such vertical relationships have been investigated theoretically by Rodríguez-Clare (1996), while Driffield et al. (2002), Blalock and Gertler (2003) and Javorcik (2004) provide empirical evidence. The importance of vertical linkages has also been recognized in the recent *UN World Investment Report 2001* (UNCTAD, 2001), which, however, focuses on backward linkages.

The first contribution of this paper is that we consider all the possible directions through which positive spillovers may occur. We distinguish spillover effects due to the presence of MNEs in the same industry as the domestic firms (i.e., horizontal spillovers) from effects due to vertical, i.e. buyer-supplier, relationships, considering both forward and backward linkages. Domestic producers buying inputs from or supplying inputs to multinationals are potentially in an ideal position to appropriate some of multinationals' FSA because of knowledge transfer that business-to-business relationships could entail.

On the one hand, contacts between foreign producers and domestic suppliers may improve the technical competencies of the latter through reverse engineering, improved product design and market information. This may lead to productivity gains. On the other

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improvement compared to that study.

hand, foreign companies supplying inputs to domestic enterprises could generate positive spillovers through the superior proprietary asset, knowledge and technology embodied in their inputs and through the training provided to employ them appropriately.

However, negative externalities may offset the potentially positive effects of both horizontal and vertical spillovers. Horizontal spillovers might be mitigated by the increased competition generated by foreign companies. Indeed, a situation may be envisaged where some firms may be forced to improve efficiency in order to be able to compete successfully with multinationals. As Aitken and Harrison (1999) argue, this competition effect may actually result in negative effects on domestic firms' productivity if multinationals "steal business" from domestic firms and force them up their average cost curve.

To tackle this issue we consider the export orientation of both domestic and foreign firms.[5] This is the second main contribution of our investigation. The idea is that domestic exporters may eschew the competition of multinationals whose output serves the domestic market. By the same token export oriented multinationals may exert less competitive pressure on domestic companies than host-country market oriented ones. Hence, this distinction goes some way towards distinguishing spillovers due to competition from those due to pure knowledge transfers.

As regards vertical linkages between domestic firms and MNEs, a potentially important reason why these might lead to negative spillovers is asymmetries in bargaining power. More specifically, foreign multinationals may be expected to have much more bargaining power than domestic companies due to their size and international operations. In this circumstance it is unlikely that indigenous firms are able to experience productivity gains fully as these may be appropriated by the more powerful contractual partner, i.e., the

[5] Apart from exporting, it would be interesting to consider the degree of import activity of multinationals as well. Import behaviour could be assumed to be a major determinant of the potential for vertical linkages, as

multinational (e.g., Klein et al., 1978, Graham et al., 1999). The larger bargaining power of foreign firms may lead to un-favouring contractual agreements towards domestic enterprises. This squeezes profits for domestic suppliers, reducing measured productivity.

Another explanation of negative backward spillovers is put forward by Rodriguez-Clare (1996). In his theoretical model foreign firms buying inputs from local supplier will generate positive productivity spillovers towards them only if they use intermediate inputs intensively and when the variety of intermediate inputs produced by domestic suppliers is not too different. If these conditions are not satisfied then negative backward productivity spillovers may arise.

The export orientation of multinationals is likely to be relevant to vertical spillovers also since it contributes to determine the degree of contact foreign affiliates have with domestic firms (in upstream and downstream industries). As regards forward spillovers, indigenous companies establish necessarily business-to-business contacts with non-exporting foreign suppliers and not with export oriented ones. Therefore they may reap the productivity benefit of the advanced know-how and technology embedded in inputs provided by host-market oriented MNEs.

Also, the export intensity of foreign companies could affect the extent of backward linkages, although ambiguously. On the one hand, exporting foreign firms are probably more isolated from the rest of the domestic economy than non-exporting ones. Hence, they may be operating in enclave sectors (Kokko et al., 2001) with little contacts with local suppliers. On the other hand, Moran (2001) drawing evidence from several case studies suggests that multinational affiliates being part of tightly integrated networks of production

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only those multinationals that source inputs from the local market can be expected to yield vertical spillovers. However, such data are not available to us, unfortunately.

(viz. those serving as export platform) develop more durable and relevant contacts with domestic suppliers.[6]

To disentangle the effect on productivity spillovers from FDI due to absorptive capacity and that due to the nature of competition between domestic and foreign firms (and captured by their export activities) in the empirical specification we also explicitly consider the absorptive capacity of firms. Recent FDI productivity spillovers studies have reported that absorptive capacity is important (i.e., spillovers differ according to how much domestic firms are distant from the technological frontier; Kokko et al., 1996; Kinoshita, 2001; Girma 2005). We take account of absorptive capacity by allowing the effect of spillovers to vary depending on host country firms' "technology gap", i.e., the distance between the firms' productivity and that of the industry leader. All other things equal we would expect that firms with higher relative productivity are more able to learn from multinationals.

3 Methodology

In line with the literature we investigate productivity spillovers from FDI by regressing firm level productivity on measures of foreign presence in related industries, controlling for a number of other covariates. To do so we proceed in two steps. Firstly, we estimate a Cobb-Douglas production function

$$\ln y_{it} = \beta_0 + \beta_l \ln l_{it} + \beta_k \ln k_{it} + \beta_m \ln m_{it} + \beta_f for + \ln TFP_{it} \quad (1)$$

where y is output and l, k, m and for are labour, capital, material inputs and an indicator of foreign ownership, respectively, to obtain total factor productivity (*TFP*)

[6] One should keep in mind, however, that Moran's (2001) case studies relate to multinationals located in developing countries. More specifically, his argument highlights two dimensions of linkages: First, the number of linkages is likely to be smaller if the multinational is part of an international network, as the network likely provides a relatively large share of inputs. On the other hand, those linkages that do exist are likely to be stronger, since the domestic supplier will, in effect, be part of the international network.

estimates for firm *i* as residual.[7] Secondly, TFP of domestic firms is regressed on foreign presence indices and other controls.

One concern with estimating equation (1) is that firms may observe TFP at least partly and that this may influence the choice of factor input combinations in the same period. Hence, there would be a correlation between *TFP* and the contemporaneous covariates, leading to biased estimates of the coefficients. This is usually referred to as a simultaneity problem. In order to deal with this we use the Olley and Pakes (1996) methodology, which suggest overcoming the simultaneity problem by using investment as proxy variables for the unobserved productivity component. In order to take into account sectoral heterogeneity we estimate equation (1) separately for each 2-digit industry. In this stage we include data for all firms, both domestic or foreign-owned.

The second stage involves regressing (log) TFP for domestic firms only on the foreign presence indices. We allow the spillover effect to vary across domestic firms according to their level of the absorptive capacity (ABC). Our assumption is that plants with higher levels of ABC are able to reap greater benefits from foreign direct investment, as they have the necessary technological ability to assimilate the knowledge available from foreign multinationals. As additional controls, we include the R&D intensity and the level of competition (measured by the Herfindahl index) in the respective industry in order to capture other sectoral variables that may be correlated with firm level TFP.

The fully specified equation is

$$\ln(TFP_{it}) = \beta' X_{jt} + \gamma_1 FDI_{jt} + \gamma_2 FDI_{jt} * ABC_{it} + d_t + d_j + \varepsilon_{it} \quad (2)$$

where X is the vector of control variables for industry *j*, d_t and d_j are time and industry dummies, respectively, FDI is the vector of foreign presence variables, which are

[7] Ideally, we would like to include the share of capital held by foreign owners. However, this is unfortunately not available in our data.

defined in the following section, and *ABC* is the measure of absorptive capacity of domestic firm *i*.

We follow Girma (2005) and compute absorptive capacity as

$$ABC_{it} = ln\ (TFP_i / TFP_{max}) \qquad (3)$$

where TFP_{max} is the maximum TFP level (i.e. the technological frontier) in the industry of firm *i*. A high level of relative efficiency is supposed to indicate technological congruity with industry leaders.[8]

4 Data and variables

The data set used covers the period 1992 to 1999 and is constructed from two main sources, namely the *OneSource* firm level panel data base for the UK supplemented by the UK Input-Output Supply and Use Tables. The *OneSource* data base includes information on all public limited companies, all companies more than 50 employees, and the top companies based on turnover, net worth, total assets, or shareholders funds (whichever is largest) up to a maximum of 110,000 companies.[9] The database includes only private companies that are in operation in 1999 and therefore excludes companies that exited prior to that year. Companies that are dissolved or in the process of liquidation in 1999 are excluded. In this paper we concentrate on manufacturing firms from this data source.

This firm level data set is one of the few UK firm level data sets to contain both foreign ownership indicators as well as information on the export status of the firm. The nationality indicators are for the latest year alone, so that it is not possible to identify when

[8] We are cautious to point out, however, that TFP is only a noisy measure of a firms' technological level, as there may, for instance, be temporary shocks that affect TFP but do not at the same time change a firms' technological capability. If anything, this should cause estimated spillover effects to be downward biased.

[9] For this study we used the OneSource CD-ROM (licensed to the University of Nottingham) entitled "UK companies, Vol. 1", for October 2000.

a firm became a subsidiary of a foreign multinational. To track the dynamics of ownership, we matched the population of manufacturing firms in the database to a list of UK firms acquired by foreign multinationals.[10]

OneSource provides information on employment, physical capital, output and cost of goods sold, in a consistent way both across firms and across time. The data were screened to select those firms for which there are complete sets of information about the value of output, factors of production and exports. Given that there is entry in the data, this left an unbalanced sample of approximately 18,000 observations containing information for around 4,600 firms. Nominal aggregates were deflated using 5 digit level industry deflators obtained from the UK Office for National Statistics (ONS).

The inputs in the production function are labour, materials and capital. The labour input is the number of employees and material is the cost of goods sold. The capital stock was computed using data on investment, with the perpetual inventory method assuming a depreciation rate of 8 percent and deflated using the GDP deflator of capital formation.

The information to construct the backward and forward linkage indices at SIC92 2-digit level was obtained from the annual UK Input-Output Supply and Use Tables. These provide information on the value of output each industry of the economy supplies as input to each other industry.[11] However, these figures contain the value of imported inputs besides the factors procured in the UK. This is problematic since the latter do not link to domestic sectors. To construct indices measuring the upstream and downstream connections between domestic firms and foreign multinationals based in the UK only semi-finished products produced in the UK and used in other production processes in the UK are relevant.

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[10] This information is confidential and is obtained from the Office of National Statistics upon special request.

For this reason we estimated the value of the factor of industry *j* produced in a foreign country and used by industry *i* in the UK (for any $i \neq j$ and $i=j$) for every year. The values of the thus estimated imported inputs were subtracted from the I-O table's figures in order to obtain the values of input *j* produced in the UK and used by any other UK industry. Further details on this procedure can be found in the appendix.

The foreign presence indicators were computed as follows: The horizontal measurement (*Hor*) is

$$Hor_{jt} = \frac{Y^{f}_{jt}}{Y_{jt}} \tag{4}$$

where the numerator is the total production of foreign firms operating in the UK in sector *j* and time *t* and the denominator is total output (i.e., output of foreign and domestic firms) of the same sector in the same year. Then, the value of this index simply represents the proportion of the total output of a given industry in a given year that has been produced by foreign firms. This is the measure most commonly employed in spillover studies.

The backward measure (*Back*) was computed as:

$$Back_{jt} = \sum_{k} \alpha_{kjt} Hor_{kt} \quad for\ k \neq j \tag{5}$$

where α_{kjt} is the proportion of the output of sector *k* supplied to industry *j*, i.e.

$$\alpha_{kjt} = \frac{Y_{kjt}}{Y_{kt}} \tag{6}$$

In the formula above Y_{kjt} is the output of industry *k* provided to industry *j*. Hence, the greater the proportion of output supplied to an industry with foreign multinational presence and the greater the foreign firms' activities in the sector receiving intermediates

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[11] The input-output tables use an industry classification different from the SIC92 classification of the *One-Source* data base. Nonetheless the tables provide the correspondence with the SIC92 classification at 2, 3 or 4 digit level. We aggregated the input-output tables' data at SIC92 2-digit level.

from industry *k*, the greater the backward index. This index has this name since the spillovers, if they exist, are expected to be towards upstream industries.

We also compute a forward measure in a similar fashion. The difference is that instead of α_{kjt} we have β_{jht}, which represents the proportion of sector *h* inputs that are provided by sector *j*. Hence,

$$For_{jt} = \sum_{h} \beta_{jht} Hor_{ht} \tag{7}$$

Thus, the greater the proportion of the output supplied by an industry with foreign multinational presence and the larger the proportion of the output of supplying industries produced by foreign firms, the higher the value of this index. The name of this index is derived from the expected direction of spillovers, which is downstream in this case.

As pointed out above, a novel feature of this paper is that we consider the export orientation of foreign multinationals also. This is likely to be an important determinant of productivity externalities. Hence, for the horizontal and backward indices we calculate two measures each, namely *Hor-Dom*, *Hor-Exp*, *Back-Dom*, and *Back-Exp*. The indices with the *Dom* suffix were computed considering the output of foreign firms sold in the UK whereas the ones with the *Exp* suffix take the output of the same firms that is exported. Such a distinction is not appropriate for the forward measure, as exporting multinationals by definition do not have any downstream linkages with domestic firms.

Summary statistics for employment, TFP and wages are reported in Table 1 for foreign and domestic firms separately.[12] As can be seen, foreign firms perform better for all three measures. The difference between foreign and domestic companies is statistically significant in nearly all years.[13] Hence, it seems to be that foreign firms may appear to be

[12] The 2-digit industry production function estimates used to calculate TFP are given in Appendix A.
[13] Note that to make meaningful comparisons between domestic and foreign companies in different years and industries the wage, employment and productivity values of Table 1 are computed as logarithmic deviations from yearly and 2-digit industry mean.

the source of productivity spillovers towards domestic enterprises since they are more productive and employ a more skilled work-force than the former.

[Table 1 here]

5 Empirical results

Table 2 shows the estimates of equation (2) based on the TFP measure calculated using the Olley and Pakes (1996) method. Since we are interested in the productivity spillovers from foreign firms towards domestic companies, these regressions consider only the latter type of firms. Column (1) is based on pooling data for all domestic firms, while columns (2) and (3) distinguish domestic exporters and non-exporters, respectively.

The coefficients reported in the table show evidence of significant horizontal spillovers from export-oriented multinationals to domestic exporters, but not to non-exporters. This effect is increasing with improvements in exporters' absorptive capacity. The point estimates in column (2), e.g., suggest that an exporter with a median level of absorptive capacity experiences a 1.2 percent increase in productivity following a one percentage point increase in horizontal export oriented FDI.[14] No such effects are observable for domestic non-exporters. The different results for exporters and non exporters are likely to reflect the fact that exporters are generally "better" than non-exporters (e.g., Bernard and Jensen, 1999). Whether this depends on management abilities, organisational structure or other factors that are likely to be internal to the firm is impossible to say in this study because of lack of data. We limit ourselves to observe that horizontal spillovers differ between exporters and non-exporters because the former are able to turn the superior technology available from foreign firms into higher productivity

[14] Calculated as (0.085 + 0.062 * -1.18 = 0.012). The median of log ABC is -1.18.

levels. The absence of any positive spillovers from domestic market oriented multinationals suggests that this type of FDI increases competition on the domestic market and, hence, any possible positive externalities are outweighed by negative business stealing effects.

As regards backward linkages, we find that there are effects from domestic market oriented FDI on domestic exporters and non-exporters.[15] Again, this spillover is increasing in the domestic firms' level of absorptive capacity and is higher for domestic exporters. This provides strong evidence that multinationals can impact on their suppliers' productivity, in line with the evidence provided by Javorcik (2004) for Lithuania.

However, in contrast to this result for backward linkages from domestic-market oriented multinationals we find that export-oriented FDI impacts negatively on their domestic supplier's productivity. This may perhaps be due to export-oriented multinationals operating in enclave sectors without significant backward linkages to the domestic economy (Kokko et al. 2001), or may be explained by the fact that domestic firms do not provide the variety of inputs foreign exporters require (Rodriguez-Clare 1996). In addition, it may indicate that multinationals have higher bargaining power than their local suppliers (Graham and Thorpe, 1999). Hence, while multinationals may teach their suppliers to be more efficient, they may in return demand a lower price for the intermediate inputs and, hence, negate any increase in output and measured productivity.[16] Unfortunately, due to data limitations we are not able to investigate the reasons for this negative effect in any further detail.

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[15] While exporters sell a proportion of their output abroad they generally do not export all of it. Hence, the share of output sold on the domestic market can be supplied to multinationals and hence create a linkage.

[16] Unfortunately, with the data at hand it is impossible to distinguish this price from a true efficiency effect. Ideally, detailed price data are necessary to tackle this issue. Katayama et al. (2003) suggest a very interesting different approach for solving this problem which, however, is based on some strong assumption about firm and industry characteristics and therefore not applicable to a study using data on a variety of sectors such as ours.

With a view to forward linkages we do not find any robust statistically significant effects, either for domestic exporters or non-exporters. Again this is in line with Javorcik (2004) who fails to establish any robust evidence for spillovers through forward linkages using micro data from Lithuania.

Examining the remaining regressors we find that the Herfindahl index is negative and statistically significant for the sample of non-exporters only. The industry-level R&D intensity is, however, positive and statistically significant in all specifications. This indicates that that there are general technological spillovers generated by the R&D activities conducted by other firms operating in the same sector.

[Table 2 here]

In estimating equation (2) using data for all manufacturing industries we implicitly assume that the effect of the explanatory variables is uniform across different industries. This is arguably a quite restrictive assumption, given that we pool firms operating in sectors with different levels of FDI and export orientation. If some unobserved industry characteristic is correlated with export activity of multinationals then it would be difficult to attribute our results to the FDI type rather than the industry type. Arguably, the inclusion of sectoral dummies in the regression mitigates this concern to a large extent, as does the inclusion of the Herfindahl index and the R&D intensity, which capture some time varying industry characteristics. However, in order to dig deeper into this issue we separate the industries in our data into those with high growth of domestic oriented FDI and those with high growth of export-oriented FDI.[17]

The results of estimating equation (2) on this split dataset are reported in Table 3. They show that, indeed, there are a number of noteworthy sectoral differences. Firstly, we

find that industries which are characterised by a high growth of domestic oriented FDI also show evidence of positive horizontal spillovers from domestic market oriented FDI. In other words, domestic firms in industries in which this segment of FDI grows over-proportionally are able to benefit from domestic market oriented FDI. Perhaps in these industries inward investors are competing with each other rather than with the local competitors, hence enabling them to learn the new technology brought into the economy.

Another important difference between the two types of industries is that only in sectors which show high growth of export-oriented FDI do we find evidence for negative spillovers through backward linkages from export-oriented FDI. This strengthens the earlier explanation that either export-oriented FDI is not linked well into the domestic economy, hence providing little potential for positive spillovers, and/or that domestic firms do not provide the required inputs and hence lose from contacts with their multinational customers at least in the short run while they are attempting to readjust production to satisfy their customers.

In both types of sectors we find that there are positive spillovers from horizontal export-oriented FDI to domestic exporters, as found in Table 2, and that they are of roughly similar magnitude. Furthermore, backward linkages from domestic oriented FDI exert positive effects on productivity of both domestic exporters and non-exporters, again underlining the results provided earlier.

Hence, while the positive effects from horizontal domestic oriented FDI and the negative backward linkage effects from export-oriented FDI seem to be sector specific, the positive results on horizontal export FDI and backward domestic oriented FDI are robust to the definition of sector. Thus, from the results discussed so far it is apparent that there are

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[17] An industry is defined to be a "high domestic-oriented FDI growth sector" if the growth rate of domestic oriented FDI exceeds that for export-oriented FDI in the industry over the sample period. Vice versa for

both intra-industry (i.e. horizontal) and inter-industry (i.e. vertical) spillovers through backward linkages. However, the sign of vertical spillovers through backward linkages depends on the nature of the operations of the multinational, i.e., whether it is export oriented or not.

[Table 3 here]

The UK government is actively aiming policies at attracting inward foreign direct investment. One aim of the policy is to secure in particular inward investment in "knowledge driven" industries (UK Trade & Investment, 2005). Hence, there is arguably a slight bias in policy towards attracting the location of what may broadly be defined as "high technology" multinationals into the country. This is partly based on the assumption that "high tech" firms have a higher potential for spillovers to the domestic economy. In order to investigate the implications of this for spillovers we split our sample into "high tech" and "low tech" sectors and estimate equation (2) separately on the two samples.[18]

The results, reported in Table 4, show that our main findings of positive spillovers from horizontal export-oriented FDI and from backward domestic-oriented FDI carry through in both sectors, although the magnitude of the effects is different in both. There are, however, some differences compared to the earlier results. We now find evidence of negative effects of horizontal domestic oriented FDI on firms in high tech sectors, and this effect is larger for non-exporters. This is likely to indicate the strong competition effect in this sector where, broadly speaking, domestic firms may be more similar to multinationals than in low tech sectors.

[Table 4 here]

"high export oriented FDI growth sectors".

6 Conclusion

Using a panel data set of UK companies from 1992 to 1999 we investigate whether or not there exist productivity spillovers from foreign direct investment. This is done considering the possibility not only of horizontal, but also of vertical spillovers and controlling for the export orientation of both domestic companies and foreign multinationals. Our findings point to the general conclusion that the export orientation of domestic and foreign multinationals alike is relevant to productivity spillovers.

Taking into account the export orientation of foreign MNEs yields interesting insights. We find robust evidence for positive horizontal spillovers only from export oriented multinationals. However, only domestic market oriented MNEs generate positive spillovers through backward linkages for both domestic exporters and non-exporters. In general our evidence underlines the importance of buyer-supplier linkages for productivity spillovers as emphasised by the UNCTAD (2001) report, which also stresses backward linkages as a conduit for positive productivity spillovers from foreign direct investment.

[18] We use the OECD classification to define high tech and low tech. See the appendix for a list of industry classification.

Appendix A

Production function estimates by two-digit SIC industry.

	SIC2 = 15	SIC2 = 16	SIC2 = 17	SIC2 = 18	SIC2 = 19	SIC2 = 20	SIC2 = 21	SIC2 = 22
Employment	0.078	0.154	0.314	0.161	0.157	0.081	0.167	0.174
	(20.22)***	(3.68)***	(6.91)***	(17.93)***	(16.01)***	(5.21)***	(21.79)***	(11.78)***
Capital	0.075	0.055	0.138	0.011	0.035	0.045	0.054	0.059
	(17.36)***	(1.61)	(5.20)***	(1.54)	(5.05)***	(8.06)***	(11.10)***	(12.78)***
Material	0.845	0.805	0.460	0.805	0.810	0.882	0.780	0.751
	(233.10)***	(29.20)***	(5.28)***	(71.95)***	(75.04)***	(54.36)***	(113.80)***	(69.73)***
Foreign	0.014	-0.093	0.253	0.086	0.042	0.116	0.049	0.031
	(1.27)	(0.96)	(4.17)***	(3.82)***	(1.43)	(3.44)***	(3.61)***	(1.71)*
Constant	0.381	0.714	1.827	1.130	0.837	0.446	0.885	1.119
	(15.99)***	(3.43)***	(7.48)***	(15.26)***	(20.76)***	(5.77)***	(25.98)***	(17.28)***

	SIC2 = 23	SIC2 = 24	SIC2 = 25	SIC2 = 26	SIC2 = 27	SIC2 = 28	SIC2 = 29	SIC2 = 30
Employment	0.013	0.106	0.169	0.213	0.162	0.265	0.216	0.087
	(0.60)	(12.51)***	(34.17)***	(28.39)***	(26.31)***	(38.80)***	(34.22)***	(3.48)***
Capital	0.099	0.070	0.049	0.064	0.030	0.048	0.031	0.053
	(4.35)***	(11.28)***	(14.87)***	(10.11)***	(5.00)***	(16.09)***	(12.81)***	(3.20)***
Material	0.846	0.814	0.783	0.721	0.801	0.678	0.746	0.863
	(41.76)***	(69.97)***	(158.27)***	(67.58)***	(127.17)***	(121.70)***	(131.07)***	(31.31)***
Foreign	0.130	0.039	0.033	-0.009	0.035	-0.001	0.005	0.180
	(2.16)**	(2.10)**	(3.05)***	(0.55)	(2.37)**	(0.01)	(0.63)	(4.01)***
Constant	0.581	0.648	0.837	1.041	0.986	1.348	1.216	0.601
	(6.20)***	(16.52)***	(33.00)***	(28.02)***	(36.38)***	(49.06)***	(48.35)***	(6.14)***

	SIC2 = 31	SIC2 = 32	SIC2 = 33	SIC2 = 34	SIC2 = 35	SIC2 = 36
Employment	0.183	0.136	0.240	0.182	0.115	0.183
	(22.12)***	(6.20)***	(27.10)***	(19.05)***	(4.17)***	(31.68)***
Capital	0.046	0.063	0.021	0.034	0.078	0.031
	(8.92)***	(4.10)***	(5.10)***	(7.47)***	(4.60)***	(10.99)***
Material	0.768	0.788	0.748	0.784	0.823	0.795
	(99.51)***	(46.34)***	(87.28)***	(103.24)***	(25.64)***	(144.60)***
Foreign	0.031	0.053	-0.010	0.015	0.200	0.062
	(1.96)*	(2.51)**	(0.66)	(2.04)**	(5.61)***	(4.14)***
Constant	0.986	0.915	1.234	0.976	0.555	0.891
	(26.50)***	(11.53)***	(30.23)***	(32.91)***	(4.60)***	(29.33)***

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

Appendix B

Computation of imported inputs

The imported inputs were estimated in this fashion. Firstly, we calculated for each year a proxy of the value of total imports of good *j* (M_*j*) that was used as intermediate (MX_*j*). This was calculated as: MX_*j*=(X_*j*/Y_*j*)M_*j*, where X_*j* is the UK intermediate demand of product *j* viz., the value of the product *j* that was used as factor of production by all UK industries and Y_*j* is the total domestic demand of the same product i.e. UK intermediate demand plus UK consumption demand. Using this methodology it is implicit the assumption that the share of the total UK demand of good *j* used as input (X_*i*/Y_*i*) is equal to the share of the value of imports of the same item employed as intermediate (MX_*j*/M_*j*).

Secondly, we allocated a certain fraction of MX_j to each industry. More specifically, the value of the imported intermediate *j* used in any other industry *i* was estimated. This was calculated as Mx_*ij*=(x_*ji*/X_*j*)MX_*j* where x_*ji* is the value of the intermediate produced by industry *j* and employed in industry *i*.

Appendix C

Correlation matrix of foreign presence indices

	Horiz. Dom FDI	Horiz. Exp FDI	Forward FDI	Back Dom FDI	Back Exp FDI
Horiz. Dom FDI	1				
Horiz. Exp FDI	0.4447	1			
Forward FDI	0.1091	0.3676	1		
Back Dom FDI	0.0773	0.1505	0.2654	1	
Back Exp FDI	0.0704	0.2539	0.2983	0.8864	1

Appendix D

Definition of High and Low tech industries

High-technology industries
Aircraft and spacecraft
Pharmaceuticals
Office, accounting and computing machinery
Radio, TV and communications equipment
Medical, precision and optical instruments
Medium-high-technology industries
Electrical machinery and apparatus, n.e.c.
Motor vehicles, trailers and semi-trailers
Chemicals excluding pharmaceuticals
Railroad equipment and transport equipment, n.e.c.
Machinery and equipment, n.e.c.
Medium-low-technology industries
Building and repairing of ships and boats
Rubber and plastics products
Coke, refined petroleum products and nuclear fuel
Other non-metallic mineral products
Basic metals and fabricated metal products
Low-technology industries
Manufacturing, n.e.c.; Recycling
Wood, pulp, paper, paper products, printing and publishing
Food products, beverages and tobacco
Textiles, textile products, leather and footwear

Note: high tech is defined as high and medium-high tech

Source: OECD: www1.oecd.org/publications/e-book/92-2003-04-1-7294/annex-1.htm

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Table 1: Summary statistics for foreign and domestic firms

	Productivity			Employment			Wages		
	Domestic	**Foreign**	**Difference**	**Domestic**	**Foreign**	**Difference**	**Domestic**	**Foreign**	**Difference**
1990	-0.007	0.020	0.027	-0.057	0.160	0.217**	-0.077	0.216	0.294**
	(0.524)	(0.578)	(0.018)	(1.212)	(1.3590	(0.042)	(1.240)	(1.422)	(0.043)
1991	-0.006	0.017	0.023	-0.073	0.194	0.267**	-0.095	0.252	0.347**
	(0.528)	(0.616)	(0.017)	(1.213)	(1.359)	(0.039)	(1.251)	(1.432)	(0.041)
1992	-0.010	0.024	0.034*	-0.079	0.192	0.271**	-0.106	0.260	0.366**
	(0.524)	(0.585)	(0.016)	(1.201)	(1.335)	(0.037)	(1.242)	(1.404)	(0.038)
1993	-0.012	0.030	0.042**	-0.078	0.186	0.265**	-0.109	0.260	0.369**
	(0.517)	(0.575)	(0.015)	(1.183)	(1.342)	(0.035)	(1.224)	(1.412)	(0.036)
1994	-0.017	0.038	0.055**	-0.078	0.172	0.250**	-0.110	0.243	0.353**
	(0.500)	(0.569)	(0.014)	(1.171)	(1.327)	(0.032)	(1.210)	(1.383)	(0.034)
1995	-0.023	0.048	0.071**	-0.093	0.194	0.287**	-0.130	0.271	0.401**
	(0.498)	(0.603)	(0.013)	(1.149)	(1.308)	(0.032)	(1.190)	(1.357)	(0.031)
1996	-0.029	0.060	0.089**	-0.104	0.211	0.315**	-0.139	0.284	0.423**
	(0.470)	(0.599)	(0.012)	(1.131)	(1.310)	(0.030)	(1.160)	(1.369)	(0.028)
1997	-0.018	0.008	0.026**	-0.074	0.035	0.109**	-0.097	0.046	0.143**
	(0.518)	(0.592)	(0.014)	(1.250)	(1.388)	(0.029)	(1.287)	(1.420)	(0.033)
1998	-0.013	0.006	0.019**	-0.105	0.049	0.155**	-0.121	0.057	0.177**
	(0.489)	(0.579)	(0.014)	(1.220)	(1.376)	(0.032)	(1.244)	(1.404)	(0.032)
1999	-0.012	0.006	0.017**	-0.101	0.049	0.150**	-0.120	0.058	0.179**
	(0.482)	(0.573)	(0.015)	(1.206)	(1.372)	(0.032)	(1.229)	(1.387)	(0.035)

Notes:

1) Values in the table are log deviation from industry (UK SIC 92 2-digit) and yearly mean
2) Standard error in parenthesis
3) + significant at 10%, * significant at 5%, ** significant at 1%.

Table 2
Heterogeneous FDI and the productivity growth of domestic firms

	ALL FIRMS	EXPORTERS	NON EXPORTERS
	(1)	(2)	(3)
Horiz. Dom. FDI	-0.038	-0.048	-0.036
	(1.15)	(1.45)	(0.41)
Horiz. Dom. FDI *ABC	-0.066	-0.067	-0.075
	(0.47)	(0.68)	(0.96)
Horiz. Exp FDI	0.073	0.085	0.059
	(3.67)***	(3.35)***	(0.80)
Horiz. Exp. FDI *ABC	0.064	0.062	0.043
	(2.35)**	(2.19)**	(0.76)
Forward FDI	-0.063	-0.125	0.129
	(0.73)	(1.19)	(0.90)
Forward FDI *ABC	0.144	0.149	0.147
	(0.68)	(1.15)	(1.04)
Back. Dom FDI	0.059	0.063	0.057
	(7.61)***	(6.89)***	(3.94)***
Back. Dom FDI *ABC	0.053	0.044	0.078
	(5.24)***	(6.32)***	(2.39)**
Back. Exp. FDI	-0.015	-0.019	-0.039
	(2.32)**	(2.23)**	(1.80)*
Back. Exp. FDI *ABC	-0.018	-0.007	-0.023
	(2.29)**	(2.03)**	(1.07)
Herfindhal index	0.003	-0.004	-0.027
	(0.60)	(0.93)	(1.82)*
R&D intensity	0.014	0.017	0.010
	(2.97)**8	(2.30)**	(2.02)**
Constant	-0.036	0.017	0.059
	(6.35)***	(3.59)***	(5.40)***
Observations	22726	14845	7881

Dependent variable is Olley-Pakes TFP measure
Regression includes constant and full set of time and two digit industry dummies
Robust cluster corrected t statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 3
Heterogeneous FDI and the productivity growth of domestic firms: Are there sectoral differences?

	High domestic-oriented FDI growth sectors			High export-oriented FDI growth sectors		
	All firms	Exporters	Non-exporters	All firms	Exporters	Non-exporters
Horiz. Dom. FDI	0.047	0.035	0.061	-0.049	-0.052	-0.392
	(2.22)**	(2.87)***	(3.09)***	(0.81)	(0.35)	(1.16)
Horiz. Dom. FDI *ABC	0.027	0.036	0.125	-0.096	-0.077	-0.026
	(1.92)**	(0.93)	(2.52)**	(0.64)	(1.10)	(1.62)
Horiz. Exp FDI	0.042	0.068	0.024	0.088	0.073	0.094
	(3.61)***	(3.12)***	(2.03)**	(7.63)***	(7.17)***	(6.72)***
Horiz. Exp. FDI *ABC	0.017	0.011	0.020	0.026	0.018	0.037
	(2.95)***	(2.14)**	(1.94)*	(2.41)**	(2.99)***	(2.48)**
Forward FDI	-0.042	-0.062	0.012	-0.042	-0.212	0.424
	(1.10)	(1.37)	(0.18)	(0.41)	(2.70)***	(1.31)
Forward FDI *ABC	-0.043	-0.042	-0.032	0.015	-0.019	0.091
	(1.84)*	(1.43)	(0.82)	(0.59)	(0.58)	(1.67)*
Back. Dom FDI	0.069	0.073	0.055	0.086	0.093	0.088
	(2.79)***	(1.94)*	(2.17)*	(3.63)***	(3.47)***	(4.78)***
Back. Dom FDI *ABC	0.035	0.033	0.038	0.024	0.026	0.016
	(7.05)***	(5.53)***	(4.46)***	(4.45)***	(9.15)***	(5.58)***
Back. Exp. FDI	-0.010	-0.068	-0.096	-0.029	-0.004	-0.067
	(1.30)	(0.69)	(1.39)	(5.12)***	(8.64)***	(5.34)***
Back. Exp. FDI *ABC	-0.010	-0.016	0.070	0.051	-0.046	-0.030
	(1.26)	(1.57)*	(1.15)	(1.13)	(1.00)	(0.49)
Herfindhal index	0.009	-0.001	-0.035	0.018	0.007	-0.006
	(1.12)	(0.12)	(2.41)**	(1.49)	(0.68)	(2.53)**
R&D intensity	0.017	0.028	0.006	0.020	0.032	0.009
	(2.21)**	(2.75)***	(2.55)**	(2.21)**	(2.42)**	(2.39)88
Constant	0.026	0.026	-0.038	0.041	-0.208	-0.212
	(4.75)***	(4.04)***	(4.18)***	(3.33)***	(11.28)***	(5.89)***
Observations	17632	11171	6461	5094	3674	1420

Dependent variable is Olley-Pakes TFP measure
Regression includes constant and full set of time and two digit industry dummies
Robust cluster corrected t statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4
Heterogeneous FDI and the productivity growth of domestic firms:
Are there high tech – low tech sector differentials?

	High tech sectors			**Low tech sectors**		
	All firms	Exporters	Non-exporters	All firms	Exporters	Non-exporters
Horiz. Dom. FDI	-0.029	-0.024	-0.046	0.061	0.063	0.046
	(2.96)***	(2.42)**	(2.07)**	(1.22)	(1.02)	(0.58)
Horiz. Dom. FDI *ABC	0.017	0.032	-0.038	0.012	0.011	0.107
	(0.40)	(0.65)	(0.49)	(1.28)	(1.11)	(1.36)
Horiz. Exp FDI	0.047	0.972	0.031	0.028	0.031	0.010
	(3.00)***	(2.65)***	(1.45)	(1.78)*	(2.32)**	(1.91)8
Horiz. Exp. FDI *ABC	0.025	0.026	0.018	0.049	0.082	0.26
	(2.30)**	(2.13)**	(0.19)	(1.54)	(0.98)	(1.50)
Forward FDI	-0.049	-0.060	-0.021	0.068	-0.061	0.080
	(1.07)	(1.11)	(0.05)	(0.63)	(1.72)*	(1.39)
Forward FDI *ABC	-0.068	-0.155	0.186	0.085	0.144	0.042
	(0.57)	(0.97)	(1.40)	(0.79)	(1.43)	(0.17)
Back. Dom FDI	0.151	0.134	-0.165	0.126	0.109	0.049
	(1.92)*	(2.06)**	(0.18)	(1.86)*	(2.44)**	(0.15)
Back. Dom FDI *ABC	0.030	0.037	0.026	0.018	0.024	0.082
	(2.25)**	(1.82)*	(0.07)	(2.12)**	(2.21)**	(0.64)
Back. Exp. FDI	-0.067	0.057	0.020	0.063	-0.094	-0.092
	(1.62)	(1.19)	(1.32)	(1.51)	(0.23)	(0.40)
Back. Exp. FDI *ABC	-0.038	-0.066	0.027	0.015	0.010	-0.082
	(1.73)*	(1.91*)	(1.31)	(0.75)	(1.18)	(0.57)
Herfindahl index	-0.005	-0.005	-0.012	0.013	-0.009	-0.019
	(0.87)	(0.65)	(1.00)	(1.96)*	(2.05)**	(0.23)
R&D intensity	0.045	0.044	0.039	0.016	0.017	0.022
	(2.31)**	(0.28)	(2.73)**	(2.80)***	(1.69)*	(2.38)**
Constant	0.005	0.008	0.013	-0.014	-0.014	-0.011
	(0.73)	(0.90)	(1.29)	(2.51)**	(3.17)***	(1.14)
Observations	8575	6642	1933	14151	8203	5948

Dependent variable is Olley-Pakes TFP measure
Regression includes constant and full set of time and two digit industry dummies
Robust cluster corrected t statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%