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The role of exporting and linkages for productivity spillovers

from FDI

by

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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.

Outline

Non-Technical Summary

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. 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. While some case studies provide evidence suggestive of positive spillover effects the results from econometric analyses are mixed.

However, the literature to-date is subject to a number of shortcomings, which can 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. 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. 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 multinational investment is quite heterogeneous with respect to its relationship with local firms, which can be assumed to have implications for any spillovers.

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. Secondly, we allow the effect of spillovers to differ for domestic exporters and non-exporters, where exporting is taken as an indicator of domestic firms' absorptive capacity to utilize knowledge flows from multinationals. Thirdly, we allow for the heterogeneity of FDI by distinguishing spillovers from primarily export oriented and domestic market oriented multinationals. To the best of our knowledge, our paper is the first to take account of all of these three issues in a consistent way. A further contribution of our paper is that we depart from the usual estimation of an augmented Cobb-Douglas production function, allowing for a more flexible specification of the production function and the spillovers externalities.

Taking into account the export orientation of foreign MNEs yields interesting insights. Only domestic market oriented MNEs generate positive spillovers through forward linkages for domestic firms. Domestic exporters also gain from backward linkages with export oriented multinationals, but experience reductions in productivity due to backward linkages with domestic market oriented multinationals. These findings are in line with some of the case study evidence by Moran (2001), who argues that domestic firms benefit more from backward linkages with multinationals that are embedded into an international production network. In general our evidence underlines the importance of buyer-supplier linkages for productivity spillovers as emphasised by the UNCTAD (2001) report. However, while the latter study stresses the importance of backward linkages alone our findings lead us to conclude that forward linkages are likely to be also conducive for positive spillovers.

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. Perhaps the most striking examples of such policies come from developed countries, with the government of Alabama paying the equivalent of $150,000 per employee to Mercedes for locating its new plant in the state in 1994 (Head, 1998). Across the Atlantic, the British Government 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. 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, Larrain et al., 2000),[2] the results from econometric analyses are mixed. As Görg and Strobl (2001) show, much of the econometric work finding positive spillovers is based on cross-section studies of industry level data, where the direction of causality is not clear and therefore cannot allow one to make reliable conclusions about the effect of multinationals on domestic productivity. However, 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

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[1] See Blomström and Kokko (1998) and Görg and Greenaway (2004) for more detailed discussions of the channels for spillovers.

[2] However, examining in detail three case studies (Ford and General Motors in Brazil, Intel in Costa Rica) Hanson (2001) concludes that there is in fact little to suggest that there are significant spillovers from these projects on domestic firms.

Czech Republic, respectively, find negative spillovers in micro panel data.[3] 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. (2002), Blalock and Gertler (2003) and Smarzynska-Javorcik (2004) argue and provide evidence that what may be more important are *vertical* rather than horizontal spillovers.[4]

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 et al., 2001). 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.[5]

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

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[3] Lipsey and Sjöholm (2004) argue that these mixed results can be explained as reflecting different firm and country characteristics in the different data sets used.

[4] Driffield et al. (2002), however, use industry level data which raises the issue of potential aggregation bias.

[5] One way to describe this heterogeneity is by looking at the degree of ownership of foreign firms. For example, Smarzynska-Javorcik and Spatareanu (2003) find that there are positive horizontal spillovers from fully-owned foreign affiliates but not from partically-owned affiliates in their firm level data for Romania. The opposite is true for vertical spillovers.

backward and forward linkages from input-output tables. Secondly, we allow the effect of spillovers to differ for domestic exporters and non-exporters, where exporting is taken as an indicator of domestic firms' absorptive capacity to utilize knowledge flows from multinationals.[6] Thirdly, we allow for the heterogeneity of FDI by distinguishing spillovers from primarily export oriented and domestic market oriented multinationals. This, as we will argue below, goes some way towards distinguishing competition effects a la Aitken and Harrison (1999) 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. A further contribution of our paper is that we depart from the usual estimation of an augmented Cobb-Douglas production function, allowing for a more flexible specification of the production function and the spillovers externalities.

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, but also due to contacts between domestic suppliers or domestic customers and multinationals.

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[6] Barrios and Strobl (2002) also use export activity as a measure of absorptive capacity in a spillover study.

These spillover channels have been described extensively in the recent literature, see, for example, Blomström and Kokko (1998) and Görg and Greenaway (2004).

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. The importance of such vertical relationships has been investigated theoretically by Rodríguez-Clare (1996), while Driffield et al. (2002) Blalock and Gertler (2003) and Smarzynska-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, largely ignoring forward 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 the leakage of information and know-how that business-to-business relationships could entail. On the one hand, foreign producers may establish relationships with their domestic suppliers in order to improve their technical competencies (as in product design and market information) which may lead to productivity gains. On the other hand, foreign companies supplying inputs to domestic enterprises could generate positive spillovers through the superior proprietary asset, knowledge and technology incorporated in their products and through the training provided to employ them appropriately.

However, negative externalities may offset the potentially positive effects of both horizontal and vertical spillovers. As regards the former, 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. 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 multinational (e.g., Klein et al., 1978, Graham et al., 1999).

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 (viz. those serving as export platform) develop more durable and relevant contacts with domestic suppliers.[7]

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[7] One should keep in mind, however, that Moran's (2001) case studies relate to multinationals located in developing countries.

In addition, distinguishing domestic firms into exporters and non-exporters also allows us to take into account a firm's "absorptive capacity", i.e., its ability to utilize the knowledge from multinationals (Kokko et al., 1996; Kinoshita, 2001). Exporters and non-exporters can be regarded as having different levels of absorptive capacity, since it has recently been shown theoretically and empirically that the latter have higher efficiency and productivity levels than non-exporters (Bernard and Jensen, 1999, Melitz, 2003). Therefore, the ability of a company to augment its productivity due to contacts with foreign multinationals in horizontal, upstream or downstream industries is likely to depend on its export status.

3   Methodology

In line with the previous literature (e.g., Aitken and Harrison, 1999, Smarzynska-Javorcik, 2004) we investigate productivity spillovers from FDI by estimating an augmented production function. The function employed in many of previous studies has the following general form

$$y_{it} = F(inputs_{it}) + G(Foreign\ indices_{it}) + \varepsilon_{it} \qquad (1)$$

where the production function $F(\cdot)$ has been usually modeled as Cobb-Douglas and the $G(\cdot)$ function has been assumed to be linear or log-linear in its arguments (i.e. indices of foreign presence).

Our approach departs from the previous literature in that both components of (1) are approximated through a second order Taylor expansion in order not to impose any specific and unduly restrictive functional form. This leaves us with two translog functions: one approximating the production function $F(\cdot)$ and the other the function $G(\cdot)$ capturing the FDI externalities. These are accounted for by a vector of variables representing the presence of foreign firms in the same, upstream and downstream industries.

The approach employed is very flexible since no specific assumption is made about the functional form of $F(\cdot)$ and $G(\cdot)$, but their additive separability. Then, the production function we estimate is the following

$$\ln y_{fit} = \beta_0 + \sum_j \beta_j \ln x_{j;fit} + \frac{1}{2} \sum_j \sum_k \beta_{jk} \ln x_{j;fit} \ln x_{k;fit} +$$

$$+ \sum_m \gamma_m \ln FPI_{m;ft} + \frac{1}{2} \sum_m \sum_n \gamma_{mn} \ln FPI_{m;ft} \ln FPI_{n;ft} + d_i + d_t + \varepsilon_{it} \qquad (2)$$

where *f* indexes industries, *i* firms and *t* time. The dependent variable used is the log of output. The independent variables are the log of inputs *x* (indexed by *j* and *k*), namely labour, capital and material, and *FPI* is the foreign presence index assumed to capture the productivity externalities.

Three *FPIs* were constructed, namely, *For*, *Hor* and *Back*. *Hor* measures the presence of foreign firms in the same sector as the domestic company. *For* and *Back* measure respectively the forward (downstream) connection between foreign multinationals and domestic firms, and the backward (upstream) connections between foreign businesses and domestic firms. The indices are described in more detail in the following section. d_i and d_t are the idiosyncratic time invariant error term and a common time effect, while ε_{it} is the remaining error term.

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 with employees greater than 50, 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.[8] Companies that are dissolved or in the process of liquidation 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 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.[9]

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

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[8] For this study we used the OneSource CD-ROM entitled "UK companies, Vol. 1", for October 2000.

value of output, factors of production and exports. 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 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.[10] 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.

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 tables 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

$$Hor_{jt} = \frac{Y_{jt}^f}{Y_{jt}} \tag{3}$$

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

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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.

Similar to Smarzynska-Javorcik (2004) the backward measure (*Back*) was computed as:

$$Back_{kt} = \sum_j \alpha_{kjt} Hor_{jt} \; for \; k \neq j \tag{4}$$

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

$$\alpha_{kjt} = \frac{Y_{kjt}}{Y_{kt}} \tag{5}$$

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 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 output that j provides to sector h. Hence,

$$For_{ht} = \sum_j \beta_{jht} Hor_{jt} \tag{6}$$

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.

The behaviour over time of these measures of foreign activities are depicted in Figure 1, which shows the yearly mean of the indices across all 2-digit manufacturing SIC 92 industries. It is notable that the mean value of these scales increased steadily over the sample period. All three indices, in particular *Hor*, rose noticeably in 1997. This time pattern underlines the increasing importance of foreign firms in UK manufacturing sectors. As the figure shows, this is not only reflected in an increasing production share (i.e. horizontal index), but also in that MNEs became more integrated into the UK economy by means of forward and backward linkages with indigenous firms. In addition, Figure 1

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[10] 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.

shows that forward linkages seem to be larger than backward ones and therefore the former may be more important than the latter in producing vertical productivity spillovers.

[Figure 1 here]

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, the three indices described above were calculated considering the exporting activities of foreign companies in the UK in order to obtain six indices, namely *Hor-Dom*, *Hor-Exp*, *For-Dom*, *For-Exp*, *Back-Dom*, *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.

Figure 2 charts the behaviour over time of the yearly mean of these indices. The first point to note is that the measures computed using the production of foreign firms sold domestically (suffixed with *Dom*) mimic the same behaviour as those in Figure 1 - a continuous increase during the sample period, along with a surge in 1997. By contrast, the indices calculated using the production of foreign firms shipped overseas (suffixed with *Exp*) show a much flatter behaviour over time. In fact, the *Hor-Exp* index even experienced a decline in 1997.

What Figures 1 and 2 combined suggest is that the increase, during the 1990s, in the relative importance of the total production of foreign firms (as depicted in Figure 1) has been due mainly to the rise of output produced by multinationals and sold in the UK (as shown in Figure 2). This phenomenon has likely diverse implications for productivity spillovers. Assuming that domestic oriented multinationals are more integrated in the host economy than export oriented ones (Kokko et al., 2001) this means an even greater relative importance of such companies in the host economy. Indeed, domestic oriented foreign affiliates may favour positive forward spillovers, by means of business-to-business links with indigenous firms. However, as Moran (2001) highlights, companies in foreign hands producing within an international network of production (i.e., serving as export platform) seem to develop more long-lasting and effective backward linkages with foreign firms, through which positive vertical spillovers may occur.

[Figure 2 here]

Whether or not foreign companies are a node of an international network of production can be investigated looking at the export propensity of foreign affiliates and domestic firms. Note from Figure 3 that the former have higher export intensities than the

latter. The yearly mean of the export share of foreign firms is around 10 percent higher than that of domestic firms for most of the 1990s.[11] Only at the end of the sample period the figures converge.

In our data set we cannot distinguish how much of the export of foreign affiliates is towards other foreign affiliates or the parent company (intra-firm trade) and so whether or not export oriented multinationals are actually parts of an integrated production systems across countries. However, data for US affiliates in the UNCTAD (1999) report indicate that most of the export of these firms is actually intra-firm trade. Furthermore it is shown that transactions between foreign affiliates are larger than those between foreign affiliates and the parent company.[12] Applying these figures to foreign companies in the UK suggests that exporting foreign firms are, likely, part of an international network of production.

An important assumption in our subsequent analysis is that the export orientation of domestic firms can be used as in indicator of its absorptive capacity, as discussed in Section 2. In order to substantiate this assumption we calculate measures of firm performance for domestic firms, distinguishing exporters and non-exporters. Summary statistics for employment, labour productivity (output per worker) and wages are reported in Table 1 for exporters and non-exporters separately. As can be seen, exporters perform better for all three performance measures. Hence, this may give some support to our assumption that exporters are more efficient and therefore have better levels of absorptive capacity than non-exporters (see also Girma et al., 2004). Also, Table 2 shows similar summary measures for the growth of output, which will be employed as dependent variable in the subsequent econometric analysis. These show that exporters have slower growth rates than non-exporters, which is not surprising, given that exporters are generally larger than non-exporters (as shown in Table 1).

[Tables 1 and 2 here]

From the summary statistics of the distribution of the dependent variable in Table 2 two features are noticeable. Firstly, the distribution is skewed towards the right and secondly, it is highly leptokurtic (the kurtosis being higher than 5).[13] These characteristics suggest the presence of outliers. In order to lessen the impact of outliers in the regression

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[11] The mean of the export share has been computed considering all firms and exporting firms only. Their behaviour is extremely similar. This suggests that the mean obtained considering both exporters and non-exporters is likely not affected by the yearly variation of the number of non-exporters in the sample.

[12] Indeed, the share of exports to other foreign affiliates (i.e., excluding parent companies) in total foreign affiliates exports was around 53% in 1993 and 62% in 1996.

we therefore excluded the top and bottom 5 percentile firms in terms of output in the empirical estimation.

5   Empirical results

We estimate equation (2) in first-differences in order to purge the firm specific time invariant effects. Since the function with the foreign indices as arguments has been approximated through the translog form the elasticities of such measures and their standard errors cannot be obtained by looking at a single parameter, as they are a linear combination of different variables and their coefficients. The elasticities for all indices have therefore been computed at the mean value of the log of the relevant variables along with their standard errors, and only these marginal effects and their robust standard errors are presented in the subsequent tables.[14,15]

Table 3 shows the results for the estimation of the specification with the total spillover indices, estimated separately for domestic exporters and non-exporters to allow for differences in absorptive capacity. It can be seen from the first two columns that there do not appear to be any statistically significant positive productivity spillovers from foreign multinationals in the same, upstream or downstream industries towards either exporting or non-exporting firms.[16] If anything, our results show evidence for negative vertical spillovers for domestic non-exporters.

The absence of any significant positive horizontal spillovers for both domestic exporters and non-exporters may reflect two things. First, it could be that MNEs are able to prevent any leakage of the firm specific asset upon which their productivity advantage is based. Second, it could be that competition with MNEs offsets any potential positive spillover effects, as highlighted by Aitken and Harrison (1999). The competition effect would be expected to apply most strongly to non-exporting firms, since they compete with

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[13] The normal distribution has a degree of kurtosis of 3.

[14] See Greene (2000, p. 286) for an explanation on how the marginal effects are calculated. The full sets of coefficient results are available upon request.

[15] The standard errors are robust to cluster-correlation (Williams 2000; Wooldridge 2002 pp. 411). Cluster-correlated data involves serial dependence within cluster induced in firm level regression by macro or industrial explanatory variables. In this specific instance, the variables causing the cluster-correlation are the indices of foreign presence since they are industry specific variables. Estimates of cluster-corrected standard errors are consistent if the number of cluster tends to infinity. In this instance we have around sixty industries, therefore it is not possible to deploy, confidently, asymptotic theory to ensure their consistency. For this reason, we considered industry-region clusters. In such a way we were able to generate more the 500 clusters.

MNEs on the domestic market. This should be less for indigenous companies selling overseas since their export activities should enable them to avoid, at least to a certain extent, the competition of foreign firms in the domestic market.

For domestic exporters, horizontal externalities could arguably depend on their export intensity, since the higher the proportion of output shipped abroad the less competition they face from foreign companies operating in the same domestic market. To further investigate this issue column 3 presents the results of the regression for exporting firms only, where the horizontal spillover measure is multiplied by the (log of) the firm's export share. To control for the possibility that firms with larger export propensity are more productive the log of the export share is included as a covariate on its own as well. It can be seen, however, that the interaction term is positive yet not significantly different from zero.

[Table 3 here]

The absence of any significant forward or backward productivity spillovers might, on the one hand, again reflect the ability of MNEs to protect successfully their firm specific asset. On the other hand, if spillovers do in fact take place, other forces may offset their positive impact. Indeed, domestic firms could benefit, in productivity terms, because of the technology and know-how embodied in inputs bought from foreign firms operating in upstream industries and, by the same token, because of their contacts with foreign clients in down-stream industries. However, these positive effects may be outweighed by the high bargaining power of foreign firms (Graham and Thorpe, 1999).

In addition, as pointed out in Section 2, the export orientation of MNEs may be relevant in this respect. Domestic market oriented foreign firms have presumably more business-to-business contacts (acting as suppliers or customers) with domestic companies than export oriented ones. Indeed, only output sold domestically by foreign affiliates creates any forward linkage with domestic companies. Besides, exporters are probably less integrated in the home economy since they are more likely to be part of an international production process that does not require the purchase of inputs locally, thus involving weaker or no relationships with indigenous suppliers (Kokko et al., 2001). However, Moran (2001) considering numerous case studies, argues that foreign plants being part of tightly integrated networks of production tend to have more intense and robust backward

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[16] These results differ from those reported by Driffield et al. (2002) who, using industry level data for UK manufacturing, found positive and significant spillovers in downstream industries only.

linkages with local suppliers than other multinational affiliates not being part of such international production processes.

The set of results in Table 4 deals with the export orientation of foreign MNEs. We would expect a negative competition effect mainly from domestic market oriented multinationals as they directly compete with local firms. We, hence, calculate the spillover indices separately for output of foreign firms sold in the domestic market and output exported. The elasticities in columns 1 and 2 in Table 4 show there are horizontal spillovers only from export oriented multinationals, while there is a negative competition effect from domestic market oriented MNEs. Furthermore, we find that both domestic exporters and non-exporters benefit from forward linkages only with domestic market oriented multinationals (although the coefficient is only statistically significant for exporters).[17] It, hence, appears that the technology and knowledge embedded in the products of domestic market oriented foreign MNEs and used as inputs by domestic companies is an important vehicle through which productivity spillovers may occur.

The results in column 2 furthermore indicate that export oriented FDI exerts a positive impact on the productivity of domestic exporters in upstream sectors. In other words, backward linkages from exporting multinationals benefit domestic exporters. On the contrary, domestic market oriented multinationals appear to reduce their productivity growth performance through backward linkages. These results are in line with the conclusion Moran (2001) draws from case study evidence. He argues that foreign affiliates producing within tightly integrated networks of production develop larger backward linkages with indigenous suppliers than those that are not part of such networks. Therefore, the positive backward spillovers from exported oriented foreign firms might well be determined by the strong linkages foreign firms establish with local suppliers. On the other hand, the negative marginal effects related to backward spillovers originated by domestic market oriented foreign enterprises might be due to the absence of such strong backward linkages along with the high bargaining power deriving from their size and international operations (Graham and Thorpe, 1999).

As regards domestic exporters, as underlined above, the export intensity may be relevant for the detection of horizontal spillovers since the larger the export intensity the

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[17] These findings are in line with those reported by Driffield et al. (2002) who find positive forward spillovers in the UK, although they do not consider the export orientation of neither domestic nor foreign firms. Our results point to the fact that such spillovers are probably generated by domestic market oriented MNEs alone.

less the perceived competition from domestic market-oriented MNEs. The last column of Table 4 reports, therefore, the results of the regression with the same variables as before plus the export share and its interaction with the index of the domestic-market oriented MNEs (*Hor-Dom*). However, the interaction term between *Hor-Dom* and the export share is statistically in significant.

[Table 4 here]

Given the potential impact of outliers, as discussed in Section 2, it appears worth checking the robustness of the results from the conditional mean models reported above to see whether these features of the dependent variable impact on the results. Hence, instead of dropping the top and bottom 5 percentile in terms of output, we use the full data set and utilise two alternative estimation strategies. First, outlier robust regression (e.g., Rousseeuw and Leroy, 1987) was used to mitigate the influence of the extreme TFP growth rate observations. Second, a median regression was estimated, where a line is fit so that the sum of absolute residuals are minimised with the view to predicting the median (rather than the mean) of the dependent variable.[18]

The estimation results are reported in Table 5. To control for heteroskedasticity and cluster-induced serial correlation standard errors have been bootstrapped with 100 replications. Generally, the bootstrap method produces asymptotically heteroskedasticity robust standard errors. However, if error terms are correlated, this methodology fails to yield asymptotically unbiased standard errors since the pattern of serial correlation is not guaranteed to be preserved during the re-sampling. Bootstrap sampling for serially correlated data have been devised mainly in a time series context (e.g. Horowitz 2001), and it has been shown that if the re-sampling scheme captures the cause of serial dependence (this rules out independent re-sample), bootstrapping will deliver heteroskedasticity and serial correlation robust standard errors. Accordingly we re-sampled clusters and not individual observations in order to ensure that the pattern of cluster-induced serial correlation is preserved in all bootstrap samples.[19]

The results of these estimations are reported in Table 5. Overall we find that the coefficients are fairly robust. We still find positive spillover effects from horizontal and

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[18] Note that median regression is a special case of quantile regression models (e.g., Buchinsky, 1998) which is appropriate in case the dependent variable is non-normally distributed. Quantile regression is robust to outliers.

backward export-oriented FDI, as well as from forward linkages between domestic market oriented multinationals and domestic firms.

[Table 5 here]

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 positive horizontal spillovers only from export oriented multinationals. However, only domestic market oriented MNEs generate positive spillovers through forward linkages for both domestic exporters and non-exporters. Domestic exporters also gain from backward linkages with export oriented multinationals, but experience reductions in productivity due to backward linkages with domestic market oriented multinationals. These findings are in line with some of the case study evidence by Moran (2001), who argues that domestic firms benefit more from backward linkages with multinationals that are embedded into an international production network. In general our evidence underlines the importance of buyer-supplier linkages for productivity spillovers as emphasised by the UNCTAD (2001) report. However, while the latter study stresses the importance of backward linkages alone our findings lead us to conclude that forward linkages are likely to be also conducive for positive spillovers.

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[19] See also Johnston and DiNardo (1997, pp. 369). The problem of clustering is well-known in household survey. Deaton (1997) presents various examples and illustrates the benefit of the bootstrap in clustered samples.

Appendix: 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. In this circumstance it was assumed that the share of the intermediate demand for input j of industry i on the UK total intermediate demand for j (x_ji/X_j) is equal to the proportion of imported factor j used by industry i (Mx_ij/MX_j).

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Table 1:

Summary statistics for domestic exporters and non-exporters

	Log employment		Log productivity		Log wages	
	Exporters	Non-exporter	Exporters	Non-exporter	Exporters	Non-exporter
Mean	4.910	4.458	4.240	4.204	2.716	2.680
Standard deviation	1.138	1.159	0.584	0.651	0.325	0.359
10th percentile	3.555	3.135	3.602	3.507	2.342	2.243
25th percentile	4.143	3.714	3.866	3.783	2.539	2.465
Median	4.787	4.290	4.175	4.117	2.732	2.680
75th percentile [h]	5.595	5.010	4.546	4.522	2.901	2.904
90th percentile	6.415	6.008	4.968	5.044	3.078	3.123

Table 2:

Summary statistics for the dependent variable (growth of output)

	Exporters	Non-Exporters
Mean	0.0346	0.0580
Standard dev.	0.2133	0.2152
10th percentile	-0.1968	-0.1716
25th percentile	-0.0748	-0.0478
Median	0.0279	0.0455
75th percentile	0.1364	0.1607
90th percentile	0.2802	0.3078
Skewness	0.1805	0.1846
Kurtosis	5.4027	5.3666

Table 3:

Marginal effects of the foreign indices from first differenced production functions and considering the export of domestic firms only

	(1)	(2)	(3)
	Domestic non-exporters	**domestic exporters**	**domestic exporters**
ln *For*	-.0723	.0151	.0121
	(.038)+	(.0286)	(.0287)
ln *Hor*	.0066	-.0049	-.008
	(.028)	(.0188)	(.0188)
ln *Back*	-.0468	-.0141	-.0161
	(.0171)**	(.0102)	(.0103)
ln *Hor* * ln *Exp.-Int.*			.0017
			(.00022)
ln *Exp.-Int.*			.0002
			(0.0026)
Observations	4137	11017	11017
R-squared	0.71	0.71	0.71

Notes:

1) Robust standard errors in parentheses

2) + significant at 10%; * significant at 5%; ** significant at 1%

3) Time dummies have been included

Table 4:

Marginal effects of the foreign indices from first differenced production functions, distinguishing MNE export activity

	(1)	(2)	(3)
	domestic non-exporters	**domestic exporters**	**domestic exporters**
ln *For-Dom*	.0749	.1333	.1359
	(.0845)	(.0493)**	(.0512)**
ln *For-Exp*	-.1606	-.0868	-.0905
	(.0666)*	(.043)*	(.0442)*
ln *Hor-Dom*	-.0165	-.0484	-.0544
	(.0352)	(.0212)*	(.0215)*

ln *Hor-Exp*	.054	.0317	.0322
	(.0183)**	(.0131)*	(.0132)*
ln *Back-Dom*	-.0928	-.0781	-.0812
	(.0448)*	(.0324)*	(.0323)*
ln *Back-Exp*	.0015	.0464	.0484
	(.0381)	(.0269)+	(.0271)+
ln *Hor-Dom* * ln *Exp.-Int.*			0.0027
			(0.0021)
ln *Exp.-Int.*			-0.0019
			(0.0028)
Observations	4137	11017	11017
R-squared	0.72	0.71	0.71

Notes:

1) Robust standard errors in parentheses

2) + significant at 10%; ** significant at 5%; *** significant at 1%

3) Time dummies have been included

Table 5:

Sensitivity analyses: Marginal effects of foreign indices outlier robust and least absolute deviations regressions

	Outlier robust Regressions		Median Regresions	
	Domestic non-exporters	**Domestic exporters**	**Domestic non-exporters**	**Domestic exporters**
ln *For-Dom*	.1901	.117	.1908	.1072
	(.0571)**	(.0439)**	(.0691)**	(.0507)*
ln *For-Exp*	-.1753	-.0378	-.1892	-.0432
	(.0485)**	(.0449)	(.0643)**	(.0473)
ln *Hor-Dom*	-.042	-.0436	-.0498	-.0486
	(.0315)	(.0227)+	(.038)	(.0224)*
ln *Hor-Exp*	.0357	.0216	.0489	.0204
	(.0142)*	(.011)*	(.016)**	(.0107)+
ln *Back-Dom*	-.0946	-.0698	-.1211	-.0444
	(.0366)**	(.0318)*	(.0501)*	(.0277)
ln *Back-Exp*	.0383	.0476	.0692	.0272
	(.031)	(.0286)+	(.0404)+	(.0252)
ln *Hor-Dom * ln Exp.-Int.*		.0025		.0019
		(.0019)		(.0017)
ln *Exp.-Int.*		-.0031		-.0022
		(.0026)		(.0022)
Observations	4397	4397	11171	11171

Notes:

1) Bootstraped standard errors with 100 replications. Bootstrap controls for clusters.

2) + significant at 10%; * significant at 5%; ** significant at 1%

(3) Time dummies have been included

Figure 1:

Behaviour of the year mean of the forward (For), horizontal (Hor) and backward (Back) indices of foreign presence
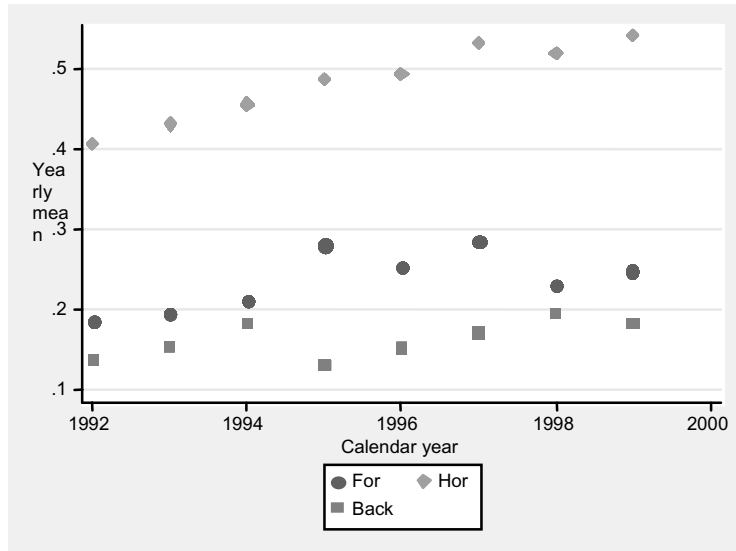

Figure 2:

Behaviour of the yearly mean of the forward-domestic (For-Dom), forward-export (For-Exp), horizontal-domestic (Hor-Dom), horizontal-export (Hor-Exp), backward-domestic (Back-Dom) and backward-export (Back-Exp) indices of foreign presence
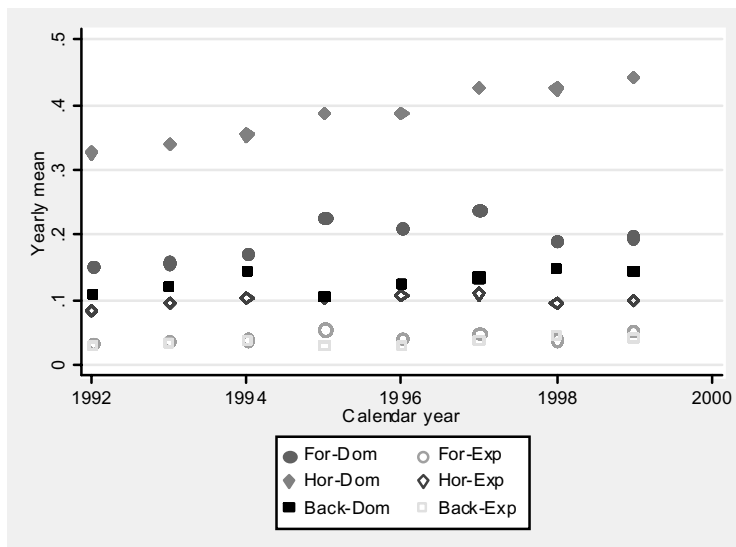
Figure 3:

Export share of domestic and foreign companies