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Industrial Linkages and Export Spillovers from FDI

by

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GEP Leverhulme Centre for Research on Globalisation and Economic Policy

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Abstract

In this paper we investigated the hypothesis of *export* spillovers from foreign multinationals to domestic firms using a data set of UK manufacturing firms from 1992 to 1999. Unlike previous studies we allow not only for the possibility of horizontal (i.e. intra-industry) and regional externalities, but also for vertical ones (i.e. inter-industry: forward and backward). Deploying and Heckman selection process we modelled the two decisions of whether to export or not, and how much to export, separately. The results indicate that the decision to start exporting is positively associated with the presence of foreign firms in the same industry *and* region; furthermore export oriented foreign affiliates seem to be the source of stronger export spillovers. The decision concerning how much to export is affected positively by foreign firms in downstream industries and by those in the same industry and region that do not export.

JEL classification: F13; F23

Keywords: FDI, export spillovers, export platforms.

Outline

Non-Technical Summary

Governments the world over try to attract FDI inflows offering various financial incentives. The rationale for this is that FDI is believed to bring many benefits to host economies, in terms of productivity, employment, R&D expenditure and so on. Productivity spillovers from FDI have been the subject of a growing empirical literature. Studies have investigated both inter-industry (i.e. horizontal) and inter-industry (i.e. vertical) spillovers. However, evidence has been mixed so far (Görg and Greenaway 2004).

One other dimension upon which FDI inflows may have an effect is exports. This topic has not yet sufficiently been investigated in the empirical literature. There are a number of reasons whereupon we can expect export spillovers to take place. The decisions whether to export or not and how much to export depend on firms productivity and knowledge about foreign markets and competition. This is because the most productive firms will be able to pay the sunk costs necessary to start exporting. Foreign affiliates, being part of an international network of production, are likely to have these information. If domestic companies are able to obtain these information, through various channels, such as worker mobility and business-to-business relationships, this will help them to start shipping goods overseas or increase their export share.

In this research project, we investigate the effect of regional and industry concentration of foreign firms on the export behaviour of domestic enterprises using a data set of UK manufacturing firms for the period 1992--1999. Empirically, we model the two decisions whether to export or not and how much to export through and Heckman selection model. Akin to the productivity literature, not only do we consider horizontal spillovers, but also vertical ones. Furthermore, we take into account the regional dimension of externalities and the export orientation of foreign firms. This is because export spillovers are more likely to be affected positively by the geographic proximity between domestic and foreign firms and because it may be reasonably envisaged that exporting foreign companies are the source of stronger export externalities.

The results suggest indeed that there are positive export spillovers from foreign to domestic companies. These can be both vertical (more specifically backward) and horizontal. There is also evidence that spillovers are stronger the higher the regional concentration of foreign affiliates and the higher the share of output they export.

1. Introduction.

Of the likely impacts foreign direct investment might have on the domestic economy the greatest research effort has concentrated on their possible indirect effect on the productivity of domestically owned firms, labelled productivity spillovers.[1] The return from this effort has been somewhat disappointing. In their recent review of the empirical literature Görg and Greenaway (2004) conclude that the evidence for generalised spillovers from multinationals located in the same industry (horizontal spillovers) might be interpreted at best, as weak. The evidence is instead stronger when the focus is on more homogeneous groups of firms, when the physical proximity is high and from multinationals located up or down the supply chain (vertical spillovers).

In contrast to productivity spillovers, comparatively little effort has been spent on identifying other indirect benefits from multinational firms, such as those on the export decision of domestic firms (export spillovers). This is despite the fact that such spillovers are perhaps more likely and where the research on this link exists, provides encouragement (see for example Aitken *et al*., 1997; Banaga, 2003; Greenaway *et al*., 2004).

Export spillovers provide the focus of this paper. Part of the contribution we make is to try to understand the relative strength of a large number of channels through which export spillovers might occur. These channels include horizontal spillovers from multinationals in the same industry, region and allowing separate effects from outward oriented and host market oriented multinationals. We also build on the productivity spillovers literature to allow for *inter-industry* (i.e. vertical) spillovers due to buyer-supplier linkages between domestic and foreign companies. To date the literature has exclusively considered *intra-industry* (horizontal) externalities (e.g. Greenaway *et al.*, 2004), while a small number have considered those occurring in a delimited geographical area (Aitken *et al.*, 1997; Sjoholm, 2003).

[1] Foreign direct investments have been seen to bring many other important benefits to the UK economy (Porter and Ketels 2003). FDI increases the level of competition in the domestic economy, and offers consumers greater choice. They are also seen as an important source of new technologies, innovation and business practice. It has become an established fact that foreign multinationals have higher productivity and superior technology than domestic firms and there is some evidence that these both help to raise aggregate productivity in the economy through the reallocation of resources. There are also important effects on employment and wages from FDI.

The expectation that the co-presence of foreign firms might impact on the export decision of domestic firms is relative simple to motivate. Within the literature on export behaviour at the firm level two stylised facts are prominent. Firstly, there is a high degree of persistence in the export behaviour of firms: if a firm exports one period is very likely to do so again the next. This is generally interpreted as evidence of sunk-costs associated with export market entry, where these costs might include, the establishment of distribution and logistic channels, product compliance and regulations, market research to acquire information about consumers tastes and market structure in foreign countries. A second stylised fact, evident across a wide range of countries and time periods, is that exporters are on average 'better' than non-exporters across a large number of performance characteristics. For example, they are larger, more productive, more capital intensive, pay higher wages and more likely to undertake R&D (Bernard and Jensen, 1995; Bernard and Wagner, 1997; Girma et al. 2004). These regularities have in turn stimulated the development of models of firm level adjustment by Melitz (2003), Helpman, Yeaple and Melitz (2004) and Bernard Eaton, Jensen and Kortum (2003). In these models the export decision of a given firm can be predicted by their ex-ante productivity level relative to the sunk-cost of export market entry. Only those firms with productivity sufficiently high can meet the necessary sunk-costs and make positive profits from export market participation.

The presence of multinational firms might be expected to impact on the export decision of domestic firms both through increasing competition and/or from information externalities. By affecting either the sunk-costs of export market entry or the productivity of domestic firms. Affiliates of foreign firms increase the level of competition within the market they enter, forcing domestic firms to become more productive (or exit), and therefore allowing them to start exporting.[2] This effect may be stronger the higher are export entry costs and the more concentrated the industry that the MNE enters is.[3] Alternatively, as Aitken *et al.* (1997) emphasise, export spillovers might involve information externalities, effectively lowering the sunk-costs associated with entry. Due to information asymmetries the costs of entry are perceived by some domestic firms to be too high, too uncertain or the profitable opportunities available in foreign markets perceived to be too low so as to discourage

[2] Note that also the reverse may happen. Aitken and Harrison (1999) argued that foreign subsidiaries may exert such a competitive pressure so as to force domestic firms to reduce their production and push them up their average cost curves. This may result in lower productivity levels and thereby a diminished propensity to export.

export market participation (Greenaway and Kneller, 2004). Co-location may then improve information about foreign tastes and markets, an improvement in the domestic infrastructure necessary to provide access to foreign markets or provide channels through which to distribute their goods (Aitken *et al.* 1997).

To the extent that information and competition export spillovers are present they are likely to differ according to whether the contact domestic firms have with foreign multinationals is horizontal or vertical. Information spillovers are more likely to occur for example, because of vertical linkages between firms, whereas horizontal linkages are more likely to result in both information and competition effects. Vertical externalities can be towards downstream industries (forward spillovers) and/or towards upstream industries (backward spillovers) and might be attributed to buyer-supplier linkages between foreign and domestic firms. We used Input-Output Tables to construct indexes capturing the forward and backward linkages between the sectors of the economy.

Buliding on Greenaway *et al.* (2004), to try to understand whether any horizontal spillovers are due to information or competition effects we further subdivide the multinationals operating in the same industry and/or region into those that export and those that do not. The hypothesis is that export oriented foreign firms are more likely to be the source of export spillovers than host market oriented foreign affiliates. This channel is likely to be similar to the strong demonstration effects from other domestic exporters in Greenaway and Kneller (2004). We then further subdivide these effects according to the geographic location of the multinational firm, where we follow Sjoholm (1999), Aitken and Harrison (1999) and Girma and Wakelin (2002) from the productivity spillovers literature in expecting that information spillovers are likely to decline across space more quickly than competition effects.

Our results indicate that there are significant export spillovers from the operations of foreign affiliates in the UK. As in Aitken *et al.* (1997) we find positive and significant horizontal and regional export spillovers concerning the decision to participate in export markets. Foreign presence leads to information spillovers which reduces the sunk-costs of exporting for domestic firms. Of the vertical linkages we find a significant vertical (backward) spillovers on the decision how much to export only. These are likely to capture

[3] Cantwell (1989) reported that the entry of US multinationals firms resulted in smaller market share of EU firms and Blomstrom and Kokko (1998) claimed that MNEs appear to establish subsidiaries in less

general information externalities that improves the firms ability to compete in international markets.

The rest of the paper is organised as follow; vertical and horizontal spillovers from FDI are discussed in section 2; section 3 highlights the channel through which vertical and horizontal export spillovers might occur and reviewed the literature that has so far investigated them. The Heckman selection model we employ in our empirical analysis is described in section 4. In the next two sections we discuss the data set, the main variables and the results. Finally, section 7 concludes.

2. Vertical and horizontal spillovers from FDI

In the past decades there has been a noticeable policy competition between governments to attract FDI.[4] Government intervention to attract multinational enterprises are based on the conviction that FDI brings several benefits to host economies. Firstly, it is believed that there are *direct* effects stemming from increases in the demand for labour, R&D expenditure, in addition to injection of additional capital in the host economy. All these factors are thought to have positive implications both at local and national level.

Secondly, it is generally believed that there are *indirect* benefits (i.e. externalities) arising from firm specific asset (FSA), such as a superior production technique, know-how, or management strategy, which multinationals are supposed to posses (Caves, 1996).[5] The possibility for positive spillovers arises because multinationals may find it difficult to protect a leakage of their 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 for instance to labour mobility between firms, but also to buyer-supplier linkages between domestic and foreign firms.[6]

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competitive industries, but not to cause them.

[4] 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. 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 .

[5] These FSAs have at least some of the characteristics of a public good and enable the firm to locate profitably abroad. They can be transferred at low or zero cost between subsidiaries of the same firm.

[6] Spillover channels have been described extensively in the recent literature, see, for example, Blomström and Kokko (1998) and Görg and Greenaway (2004).

Spillovers from FDI are typically classified into one of two categories according to their 'direction': *horizontal* (*intra-industry* spillovers), and *vertical* (*inter-industry* spillovers). As put forward convincingly by Blyde, Kugler and Stein (2005) , the main difference between them is that the former are more likely to involve sector specific technical knowledge that would benefit competitors. There is therefore greater incentive to prevent spillovers of this type. Possible channels through which such spillovers might occur are the acquisition of human capital (MNEs train local workers, on specific production techniques, who may be subsequently hired by indigenous businesses taking the acquired human capital therein), and imitation (reverse engineering).

Vertical spillovers are likely to concern general rather than sector specific technological knowledge and would bring benefits those firms in upstream industries (suppliers) and downstream industries (buyers) which foreign affiliates deal with. These firms represent stakeholders of the subsidiaries of MNEs, not direct competitors, and therefore foreign affiliates may have some incentive to share general technological know-how with them, in order to achieve higher degree of co-ordination and automation in their production activities, and thereby higher profits.[7]

The importance of buyer-supplier linkages between foreign and domestic firms for spillovers has been underlined by several authors. Dunning (1993) claimed that the incentive for foreign affiliates to share general technical knowledge with firms in upstream and downstream sectors with which they have business linkages may have effect on both the quantity and quality of the inputs supplied. Reviewing the literature to date he affirmed there was little doubt that foreign affiliates raise the quality of inputs produced and the productivity of suppliers.

Theoretical models have dealt with the effects of linkages between foreign and domestic enterprises. Rodriquez-Clare (1996) shows how linkages between foreign subsidiaries and indigenous firms may boost the productivity of the latter. Similarly, Markusen and Venables (1999) argued that contacts between domestic and foreign enterprises (supported by production complementarities and scale economies) may foster the development of domestic sectors with wider consequences for the host region and industry. They also link

[7] More specifically, backward and forward linkages between foreign affiliates and domestic suppliers and clients might involve design, procurement, market information and tooling.

vertical spillovers to market structure. Backward spillovers may occur if foreign affiliates establish a supply arrangement to encourage competition in the upstream sector.

Thus far empirical evidence about inter-industry and intra-industry spillovers have regarded productivity only. Findings on horizontal spillovers have been so far rather inconclusive (see Görg and Greenaway (2004) for a review of the literature) with some studies even reporting negative horizontal productivity spillovers (e.g.: Aitken and Harrison, 1999). The lack of evidence of positive productivity spillovers may due to the fact that foreign affiliates are successful in avoiding leakage of sector-specific technical knowledge on which their success is based. Other studies have reported significant vertical productivity spillovers (e.g.: Smarzynska-Javorcik 2004; Girma, Görg and Pisu 2004; Blyde, Kugler and Stein 2005); this corroborates the hypothesis that MNEs might have incentives in sharing generic technical knowledge with buyers and suppliers.

3. Export spillovers from FDI

One channel trough which horizontal export spillovers may occur is *competition*. This effect may be stronger the higher the entry cost and the more concentrated the industry MNEs enter is. Cantwell (1989) reported that the entry of US multinationals firms resulted in smaller market share of EU firms and Blomstrom and Kokko (1998) claimed that MNEs appear to establish subsidiaries in less competitive industries, but not to cause them. Foreign firms affiliates will render the market they enter more competitive, forcing domestic firms to become more productive (or exit), and therefore allowing them to start exporting.

Another way by which export spillovers might occur involves *information externalities*, as emphasised by Aitken *et al.* (1997). As it has been shown empirically and theoretically (e.g.: Bernard and Jensen (2004); Melitz (2004); Bernard *et al.* (2003)) exporting involves sunk costs. These might include, the establishment of distribution and logistic channels, product compliance and regulations, market researches to acquire information about consumers tastes and market structure in foreign countries. These sunk costs are probably lower for subsidiaries of MNEs as they are part of an international production network and therefore have information about foreign markets. Export spillovers may take place if there is a transfer of knowledge about foreign markets to domestic firms. From the supply side this may lower sunk costs so that the marginal firm finds it profitable to start exporting or

to increase their share of production sold overseas by existing exporters. Or from the demand side it may increase awareness and demand for UK produced goods in overseas markets pulling firms into exporting. Like productivity spillovers, these competition and information export spillovers may be intra-industry or inter-industry in nature and may depend on the geographic proximity between domestic firms and foreign affiliates.

Proximity to foreign affiliates might be conducive to stronger export spillovers since it facilitates the acquisition of those knowledge parts and competencies and so on that might lead to exports. Aitken *et al.* (1997) address this point explicitly creating an index of foreign multinational presence operating in a certain industry *and* region in Mexico. In this respect we follow them.

However, export spillovers might not simply stop at the region border. Firstly, because the determination of those administrative regions within which externalities are supposed to materialise is from an economic point of view arbitrary. Secondly, because contacts between indigenous and foreign companies, albeit stronger within regions, may occur between regions also. Thirdly, while information externalities might be geographically concentrated, competition effects are less likely to. For these reasons, whilst we include measures of regionally constrained spillovers, we do not preclude contacts between firms operating in different regions in our analysis.

It is worth noting that spillovers can be either intra-indutsry or inter-industry, since information about export opportunities may spread across markets and industry through, inter alia business-to-business linkages between firms. We assume that only those that operate through horizontal linkages are likely to have a geographic dimension.

With respect to information externalities, the export orientation of foreign affiliates is another likely important factor. As Kneller and Pisu (2004) showed for the UK, firms owned by foreigners are more likely to export and when they do, they export more intensively than domestic firms.[8] Export oriented foreign firms are more likely to be the source of export spillovers than host market oriented foreign affiliates. This is because exporting foreign subsidisers have specific information about selling goods in foreign markets. Under this hypothesis, information may leak to domestic businesses enabling them to export. Host market oriented foreign firms, although may have information about

foreign markets, because of being part of a trans-national production system, are less likely have specific knowledge concerning sales of products overseas. This is likely to result in less strong export spillovers by such foreign affiliates.[9] In the analysis that follows we take into account of this possibility.

Therefore, we establish a rich set of possible interactions between domestic and foreign firms: These include industry and region specific aspects, components specific to export orientated multinationals as well and inter-industry and intra-industry dimensions

As noted already, the literature on export spillovers is limited compared to that about productivity spillovers - some 40 studies on productivity spillovers are listed in Görg and Greenaway (2004), compared to just five on export spillovers. Thus far the literature has concerned itself exclusively on horizontal spillovers, although Aitken *et al.* (1997) add a regional dimension to these. The evidence from this approach is somewhat mixed. While the earlier literature identified strong positive spillover effects (Aitken *et al*., 1997; Kokko *et al*., 1997; Greenaway *et al*., 2004) more recent studies have either found no and in some cases negative impacts (Barrios *et al*., 2003; Ruane and Sutherland, 2005).

Outside of differences in the country from which the underlying data are taken there would appear little obvious explanation for these inconsistencies. There is little variability in methodology and almost all use the same measure of foreign presence, the sum of employment or output in the industry. There is some mixed evidence of a dependence on income or region however, although not consistently so. Using a firm level data set of manufacturing plants in Mexico for the 1986-1989 period, Aitken *et al.*(1997) find the probability of exporting by domestic firms is increasing in the concentration of exports of foreign firms operating in the same industry and region as domestic companies. This result is robust to the inclusion of additional variables and changes in the sample. Similarly Kokko *et al.* (1997) find for Uruguay that foreign firms established after 1973 (this corresponds to the outward-oriented period of Uruguay) positively affect the probability of exporting of domestic firms. Sjoholm (2003) departs slightly in using the sum of total FDI in the region to measure foreign presence. As in this paper he is concerned about cross-

[8] Feanberg and Keane (2003) and Hanson *et al.* (2001) have documented the importance of exporting strategies for US foreign affiliates.

[9] It is worth noting that one channel by which export spillovers might take place from exporting subsidiaries of MNEs is simply through imitation. Export activities to particular destinations by perceived successful businesses (i.e. foreign firms) might simply signal to domestic firms profit opportunities in shipping goods overseas, and therefore they may start to do the same.

industry spillovers, but does not weight these according to the degree of contact with other industries. Sjoholm (2003) finds for Indonesian manufacturing firms FDI in the region had no significant effect on exports.

Using samples from European countries Greenaway *et al.* (2004), Barrios *et al.* (2003) and Ruane and Sutherland (2005) all reach contrasting conclusions. Greenaway *et al.* (2004) for the UK, found that both the likelihood of exporting and the export share are increasing in the industry-level foreign presence index, even controlling for firm level and industry level characteristics. They obtain less clear result for the index measuring the export activities of foreign firms, this being positive and weakly significant for the export decision and being positive and insignificant in the decision of how much to export.

Adopting the same methodology as Greenaway *et al.* (2004), Ruane and Sutherland (2004) also separate the foreign presence of multinationals (their employment share) from the export share of foreign multinationals. Using data for Ireland, they find positive effects from the first and negative effects from the latter on both the export decision and the export share (with a suggestion the latter is due to the presence of US multinationals). They explain the latter results as being due to the use of Ireland as an export platform to the rest of the EU. Export spillovers they argue are unlikely where the country is used as an export platform because competition with domestic firms in local product markets is limited. Finally, Barrios *et al.* (2003) for Spain find no evidence of an effect on the export decision from MNEs (although other foreign firms do appear to benefit) or the export share.

4. Empirical methodology.

In this exercise we are interested in modelling the export decision of domestic firms. Because of sunk costs of exports, this can be thought as a two-stage decisional process, whereby firms firstly decide whether to export or not and secondly how much to export.[10] This problem involves estimating an endogenous sample selection model, also known as

[10] This is against the argument put forward by Wagner (2004). He argues that the two decisions are actually the same. However, this line of reasoning does not take into account sunk costs of export, which have been shown to be, theoretically (Melitz, 2004; Helpman *et al.*, 2004; Bernard *et al.*, 2003) and empirically (e.g.: Bernard *et al*., 2004), the main reason why some firms export and some others do not. Firms base their present decision to export or not on the discounted value of future profits. Firms will export today if this

Tobit type II model (see Hsiao, 2003 pp.229--230) and Duncan (1980). This methodology is similar to the Tobit or truncation model, insofar as it deals with a censored or truncated variable (a censored one, export shares, in this case), but in addition it allows to treat the censoring or truncation value as endogenous.

Two equations were estimated,

$y^*_{it} = x_{it}\beta + u_{it}$ (export share regression);

$d^*_{it} = z_{it}\gamma + v_{it}$ (export decision);

with

$y_{it} = y^*_{it}$ if $d_{it} = 1$

$y_{it} = 0$ if $d_{it} = 0$

and

$d_{it} = 1$ *if* $d^*_{it} > 0$

$d_{it} = 0$ *if* $d^*_{it} \leq 0$

Thus, the observed export share (y_{it}) is zero when the firm decides not to export ($d_{it} = 0$) and assumes a positive value when the firm decides to export ($d_{it} = 1$). The distribution of the error terms (u_{it},v_{it}) is assumed to be bivariate normal with correlation ρ. The two equations (i.e. decisions) are related if $\rho \neq 0$. In this case estimating only the export share regression would induce sample selection bias in the estimate of β since the error tem u_{it}, and the regressor x would be correlated. To avoid this problem both equations must be estimated. The estimation can be conducted via maximum likelihood or two-step method proposed by Heckman (1979). We employed the former since it is more efficient than the latter.[11]

The vectors of covariates x_t and z_t may the same. If this is the case, and if $\gamma = \beta$ and $u = v$ (i.e. $\rho = 1$) the model reduces to the Tobit: the two choices (whether to export or not and how much to export) are the same. In this instance, the explanatory variables will affect exporters and non-exporters in the same way. The model is, in principle, identified, but identification relies exclusively on the model and the normality assumption concerning the

value is positive. The present profits, however, may well be negative because of the presence of high sunk costs related to start exporting.

two error terms being correct. These assumptions are in most cases too weak (Johnston and DiNardo, 1997 pp. 450).

For this reason, we estimated the two equations adding in the selection equation (equation modelling the decision whether to export or not) the lagged export dummy. This is theoretically consistent with the recently developed models of exports (Melitz, 2004; Helpman *et al.*, 2004; Bernard *et al.*, 2003) and in addition it has the advantage of helping to identify the model more easily. If the lagged of the export dummy is significant and positive, as we expect, there is evidence of sunk costs of exports.

5. Data and variables

The United Kingdom is a relatively large industrialised economy, the fifth largest exporter of manufactures globally and the second largest host to FDI. Unfortunately the UK production census (the Annual Respondents Database) does not collect information on exporting activity of firms. Therefore in order to make progress on this issue, we use the firm level survey OneSource which does have data on exports. Further details on the OneSource dataset can be found in Oulton (1998) and previous applications found amongst others in Conyon, Girma, Thomson and Wright (2002), Girma, Greenaway and Kneller (2004) and Greenaway and Kneller (2004).[12] OneSource provides information on employment, physical capital, output and cost of goods sold in a consistent way both across firms and across time.[13] The data were screened to select those firms for which there are a complete set of information about the value of output, factors of production and export. Companies that are dissolved or in the process of liquidation were also excluded.

The OneSource dataset contains information about the foreign-ownership status of the firm for the latest year alone, such that it is not possible to identify when a firm has become a subsidiary of a foreign multinational. To track the dynamics of ownership, we matched the population of manufacturing firms in the database to the list of U.K. firms acquired by

[11] The two-step methodology involves estimating first the probit of the export decision (i.e. selection equation), computing the inverse of the Mills ratio and inserting it as regressor in the export share regression. Although, this method is easy and intuitive is less efficient with respect to the maximum likelihood method.
[12] *OneSource* uses a non-stratified sample with an oversampling of large firms. Given that exporters have consistently been found to be larger than non-export firms this is unlikely to be of concern in this study.
[13] For this study we used the *OneSource* CD-ROM entitled "UK companies, Vol. 1", for October 2000.

foreign multinationals. This data was supplied by the Office for National Statistics (ONS) in the UK.[14]

For domestic firms the probability of export and the export intensity have been found to be increasing in the size and productivity of the firm (Greenaway and Kneller, 2004). Similarly, Bleaney and Wakelin (1999) for the UK and Wagner (2004) for Germany report evidence of a significant relationship between size and exports. Finally, the level of skill embodied in the workforce may play an important role in the export behaviour of the firm since better workers may lead to better quality product and higher levels of efficiency (see Bernard and Jensen (2004) for a similar argument). All these firm-level variables and their squared terms have been used in modelling the export decision of firms estimating equation 1 and 2. More details about the construction of these covariates can be found in Table A1 in the appendix.

In this exercise we want to assess the extent of horizontal and vertical export spillovers from foreign firms towards domestic companies. Therefore, we need some index capturing the presence foreign firms in each industry and the forward and backward linkages between domestic and foreign firms. These indexes were computed as follows: The horizontal measurement (*Hor*) is

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

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 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.

As pointed out above, we are also interested in geographical concentration and in the export orientation of foreign firms. These are likely to be two important determinants of export spillovers. On the one hand, exporting foreign affiliates may have specific information about foreign markets; on the other hand, domestic firms might benefit from export

[14] This information which is in hard copy format is obtained from the Office of National Statistics upon special request. The matching process required considerable effort, and we wish to thank Mehtap Hisarciklilar for helping us in this regard.

spillovers only if they are located near (i.e. within the same region of) foreign affiliates. Obviously, these may not be alternative but complementary phenomena.

Hence, horizontal indexes were calculated considering the exporting activities of foreign companies in the UK to obtain *Hor-Exp and Hor-Dom*. The indices with the *Dom* suffix was computed considering the output of foreign firms sold in the UK whereas the one with the *Exp* suffix take the output of the same firms that is exported.

To take into account the regional dimension, the horizontal industry-region foreign presence indexes were computed considering only those firms operating in a certain region and industry. Then, for say, industry *j*, region *r* at time *t* the index is[15]

$$Hor \quad industry \quad region_{jrt} = \frac{Y^{f}_{jrt}}{Y_{jrt}} \tag{4}$$

To capture horizontal spillovers from foreign firms located in different regions (indicated as $\bar{r}$) we also calculated

$$Hor \quad industry_{j\bar{r}t} = \frac{Y^{f}_{jt} - Y^{f}_{jrt}}{Y_{jt} - Y_{jrt}} \tag{5}$$

To control for the export propensity of foreign firms and their geographical concentration at the same time we computed other two variants of the indexes in 4 and 5. The first uses in the numerator the output of foreign firms sold in the host market; the second uses in the numerators the output that has been exported. We labelled these indexes as those above with the only difference that the suffixes *Exp* or *Dom* are added respectively.

The information to construct the backward and forward linkage 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. The input-output tables use an industry classification different from the SIC92 classification of the *One-Source* data base. Nonetheless the I-O Tables provide the correspondence with the SIC92 classification at 2, 3 or 4 digit level. We computed the industrial linkage indexes, as the horizontal ones, following the classification of the Input-Output Tables and used the

[15] The region classification in our data set is: Central London, Central Southern, East Anglia, East Midlands, Home Counties Outside M25, North East, North Scotland, North West, Outer London Inside M25, South East, South West, Southern Scotland, Wales & Welsh Borders, West Midlands.

correspondence table to match the SIC92 sectors in our firm-level data set with those in the I-O Tables.

However, figures in the I-O Tables 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.

Similarly to Smarzynska-Javorcik (2004) and Girma, Gorg and Pisu (2003) the backward measure (Back) was computed as:

$$Back_{kt} = \sum_{j} \alpha_{kjt} Hor_{jt} \qquad for\ k \neq j \tag{6}$$

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

$$\alpha_{kjt} = \frac{Y_{kjt}}{Y_{kt}} \tag{7}$$

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,

$$For_{ht} = \sum_{j} \beta_{jht} Hor_{jt} \qquad for\ k \neq j \tag{8}$$

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 horizontal, forward and backward indexes were then added in the export decision equations to be estimated along with other firm and industry level controls. Among the sector-level variables we control for we include a measure of technology (R&D intensity inn the industry) and the industry export share. If trade flows (and hence exports) are driven by comparative advantage, the industry export share should capture these effects, whereas if, as in a Ricardian framework are based on technology differences then the industry R&D intensity variable should capture this effect. Therefore, 'more technology advanced industries' may have some comparative advantage with respect to other 'less technology advanced' sectors thereby exporting more. In addition, these variables control for the possibility that foreign firms choose to locate in more technology advanced or export intensive industries, while the latter may also capture horizontal export spillovers due to the exporting activities of domestic and foreign firms more generally. All regressions contain industry, region ands time dummies.

Before discussing our estimation results at firm-level it would be useful to explore the relationship between our foreign indexes and technology variable with industry export shares to assess whether or not these controls are likely determinants of export performance.[16]

Figure 1 exhibits the graph of the yearly industry export shares against the forward, horizontal and backward index and the R&D investment share. These are all variables that are likely to affect the export propensity of industries: foreign multinationals may be the source of export spillovers and have been found to be more export oriented than domestic companies (Kneller and Pisu, 2004); R&D expenditure determines industries comparative advantage.

As it is possible to note in Figure 1, although there are non-linearities in these relationships, there appears to be a clear positive relationship between all these variables and the industry export share. The higher these indexes, the higher the industry export share. All these

measures might be correlated with each other since foreign firms might be concentrated in R&D intensive sectors, and their operations affect the backward and forward linkages measures. For this reason, Table 1 presents the regression results of the industry export share on the foreign indexes and the R&D share. It is possible to see how all these measures appear to be positively and significantly correlated with the yearly industry export share. The results concerning the foreign indexes are suggestive of knowledge spillovers from foreign multinationals, which results in higher export share. However, this interpretation for the *Hor* index may tempered by the fact that foreign firms are in general more export intensive than domestic firms and contribute notably to the export performance of the British manufacturing sector (Kneller and Pisu, 2004).

Figure 2 depicts the relationships between the yearly industry export share the *Hor Exp* and *Hor Dom* indexes. Anew, these appear to be positive, albeit there are important non-linearities. From these graphs it would appear that both export and domestic oriented foreign affiliates multinational are positively correlated with the export intensity of manufacturing sectors. However, as it possible to see in Table 2 when the *Hor* is substituted with *Hor Exp* and *Hor Dom* the former is positive, the latter is negative and *Forw* becomes insignificant. These results seem to confirm that foreign multinationals in the UK contribute notably to the export performance of manufacturing industries through their exporting activities.

Thus, at industry level there seem to significant correlation between foreign presence indexes, R&D investment and export share, which suggest that these measures might be important determinant of export performance, possibly through spillovers. To investigate in more in details this possibility we turn now to firm-level data.

6. Empirical results

The results of the Heckamn selection model are shown from table 3 to 6.[17] The covariates used are at firm-level and industry-level.[18] We include among the latter the yearly industry

[16] Obviously, from this analysis nothing can be inferred reliably about export spillovers since industry level data are ill suited for this kind of investigation (Gorg and Greenaway, 2004).
[17] All standard errors are robust to cluster (industry) correlation to account for the fact that we have industry level variables in a firm level variable regression (Williams 2000; Wooldridge 2002 pp. 411). This may lead to under-estimated standard errors if correlation of the error term induced by the macro-variables is not taken into account (Moulton 1990).
[18] All firm-level variable are lagged by one year.

export share, the R&D share, along with the foreign presence indices described in the previous section. Table 1 presents the results obtained considering the *Forw*, *Hor* and *Back* indexes; the measures of foreign presence without controlling for differences between regions or exporters. In column 1 reports the results of the zero-one export participation decision equation, and column 2 the decision how much to export.

The firm-level characteristics in column 1 have the expected sign and support previous findings for the UK and other countries (Girma *et al*., 2004; Bernard and Jensen, 1995; Bernard and Wagner, 1998). To begin with, the export decision seems to depend strongly on the previous export status of the firm: if a firm exported the year before it is much more likely to export this period also. This is consistent with the presence of sunk costs of export market entry, since they create hysteresis in the export behaviour of firms. The other firm-level variables indicate that the probability of exporting is increasing in the wage per employee and in the size of the firm. This may reflect the fact that firms with high skilled workers (and therefore higher wages) and large firms are more likely to be able to compete successfully in international markets. The productivity variable is positive as expected, but insignificant.

Amongst the industry level variables the export share and the R&D share have an insignificant effect on the export market participation decision. This result would appear to be driven by inclusion of the fixed industry effects. All the three indexes of foreign presence are insignificant in the probit regression. There are no productivity spillovers from foreign to domestic firms, neither horizontal nor vertical, when the export orientation and the location of foreign affiliates are not taken into account.

In the export share regression (column 2) firm-level characteristics such as wage and productivity are found to have a positive and strongly significant effect, whereas the size variable is now insignificant (for comparison see *Greenaway et al.* 2004). Of the industry level variables, both the industry export share and the R&D share are again insignificant.

The results concerning the foreign presence index tell a quite different story for export intensity from the export participation decision. *Forw* is still insignificant, the horizontal index *Hor* is positive and weakly significant and *Back* is positive and strongly significant. Foreign multinationals operating in the same industry as domestic firms and in upstream sectors appear to be a source of export spillovers towards domestic companies. Given that

exporters have been found to have better performance across a wide range of characteristics than non-exporters (Greenaway and Kneller, 2004) this result is consistent with the idea that spillovers occur only when the technology gap is sufficiently small (Girma, 2002; Girma and Görg, 2002).

The horizontal spillover effect on the export intensity of firms only differs from the positive spillover effect on both export dimensions reported in previous studies. Aitken *et al.* (1997), Kokko *et al.* (1998) and Greenaway *et al.* (2004). Aitken *et al.* (1997) and Kokko *et al.* (1998) report a positive effect on the export participation decision (i.e. the probit regression) and Greenaway *et al.* (2004) on both export market participation and the export share. We, after controlling for previous export market experience, find only weakly significant effect only on the decision how much to export. This difference to previous work is probably due to the inclusion of a measure of sunk costs of export market entry through the lagged export status of the firm here. When this variable is removed a numbr of the foreign presence variables become significant. The inclusion of this variable is crucial to identify the model correctly however, the maximum likelihood (ML) does not converge when it is excluded indicating that the model without it is miss-specified.[19]

With regards vertical spillovers, only backward linkages between foreign multinational enterprises and indigenous firms have a significant (and positive) effect on the share of production that the firm will export if it decides to do so. These results then suggest that, as for productivity spillover studies, business to business linkages between firms may lead to informational externalities and therefore need be taken into account for a complete characterisation of spillovers. This may caused by the nature of vertical spillovers, which are likely to concern, not sector and foreign market specific information, but non-sector specific know-how, which simply allow them to compete more successfully in international markets once the sunk costs of exports market entry have been met.

In order to make some progress on whether the export spillover effect identified above are due to information or competition effects the previous literature has added to the regression

[19] In addition, given the strong export persistence excluding the lag of the export dummies is likely to result in biased estimates for all the other variables in both equations. Taking the two-step results as a benchmark (since the ML results are not available in this case) all firm level variables and all foreign presence indexes were strongly significant in both equations if the sunk costs of exports were excluded. If the latter were included the estimates were very similar to those obtained via ML. This indicates that not allowing for the sunk costs of exports results in biased estimates. These results are not reported for reason of space, but are available upon request.

a measure of exports by foreign multinationals, with the view that such a variable is more likely to capture information effects. We follow the same process using a measure of the export orientation of foreign affiliates. Exporting foreign affiliates may generate different export spillovers from those orientated at the host market only through imitation or information about foreign markets. Such effects are not certain however, Ruane and Sutherland (2005) explain the negative effect of foreign multinationals on the export decision of Irish firms by the use of Ireland as an export platform. Exporting foreign affiliates may be less likely to compete with host firms in the domestic market and maybe source most of their inputs from abroad, the net effect of which is fewer opportunities for export spillovers. This is likely to be an important issue given that export oriented FDI is an increasingly important FDI strategy (UNCTAD, 1998).

Table 4 presents the results of the selection model estimated including the measures of the export orientation of foreign firms, *Hor-Exp* and *Hor-Dom*.[20] It appears from column 1 that the export orientation of multinational enterprises is an important determinant of export spillovers, while the effect of vertical spillovers remains largely unchanged. Indeed, there is evidence of horizontal export spillovers from export oriented foreign firms only. Export oriented MNEs significantly increase the probability of exporting for domestic owned firms operating in the same industry, whereas no such effects occur from host market oriented foreign affiliates. This may be due to imitation effect, to knowledge spillovers about foreign markets opportunities, which lead some domestic firms to start exporting. In contrast to export participation there are no horizontal spillovers on the export intensity of the firm.

The combination of a significant effect on the participation decision but no effect on the export intensity of the firms in Table 4 provides strong support for the idea that export orientated multinationals help provide information that helps domestic firms to overcome the sunk-costs of exporting. The inclusion of the lagged export status of the firm in the probit regression would suggest that the increased share of domestic output and exports by foreign firms in the UK has led to increased export market entry over the sample period. This may be due to the information spillovers about foreign markets and tastes that leaked from exporting foreign businesses that occurred. Or more simply the exporting activities of

[20] We comment only of the foreign presence indexes since the estimates of the coefficients of the other variables are unchanged from the previous specification.

foreign affiliates may have made domestic firms more aware of the profit opportunities in overseas markets, which led to imitation.

If information rather than competition drives the above results effects we might expect that they are likely to decline quickly across space. In the remainder of the paper we add to our foreign presence indicators their geographic proximity. We precede by firstly including the regional indexes alone before then also accounting for the export orientation of foreign firms (Table 6). Table 5 exhibits the results obtained considering the industry-region specific foreign presence index (*Hor-Ind-Reg*) and the index of foreign firms operating in the same industry and different regions (*Hor-Ind*). The results would appear to confirm this hypothesis. The probability of exporting appears to increase the higher the geographical concentration of foreign firms operating in the same industry and region as domestic companies. On the contrary, foreign companies in the same industries and different regions do not seem to exert any effect on the probability of starting to export. Horizontal linkages, whether with foreign firms in the same or different regions, have a small, and weakly significant, effect on the export intensity regression.[21] As before vertical linkages do not seem to have any statistically significant effect on the decision of whether to export or not, although the decision concerning how much to export is again affected positively by backward spillovers.

In Table 6 we assess the relative importance of geography versus the export propensity of foreign firms using the indexes calculated considering both the regional and export dimensions. As it is possible to see both industry-region specific foreign indexes are positive and significant, although only weakly, for the export decision to start exporting. This would appear to be due to collinearity between these two indexes however, when considered jointly they are strongly significant. [22] In contrast, the indexes of the presence of exporting and non-exporting foreign firms operating in the same industry and different regions are both insignificant. This would seem to suggest that the geographic proximity of domestic enterprises to foreign affiliates is a stronger determinant of export spillovers than the export orientation of the latter. The strong (and positive) statistical significance of *Hor-Exp* in table 4 may then be generated by the fact that exporting foreign firms tend to be

[21] The p-values are 0.069 and 0.091 for *Hor-Ind-Reg* and Hor-*Ind*, respectively

[22] The p-values from the t-test for *Hor-Ind-Reg-Exp* and *Hor-Ind-Reg-Dom* are 0.087 and 0.069, respectively. A test of the joint hypothesis that the coefficients of the two variables are both zero is rejected at the 5 per cent significance level (the χ^2 statistics with 2 degree of freedom is 7.32; p-value is 0.0257).

geographically concentrated. As before, vertical linkages do not appear to have any effect on the probability of exporting.

Looking at column 2 it is possible to see that backward spillovers are still positive and strongly significant. What is different from the previous tables is that now there appear to be statistical significant horizontal spillovers from host-market oriented FDI located in the same region as domestic companies. This might be due to competition effect in the domestic market, which leads indigenous business to increase their share of output sold in overseas markets.

To understand the economic magnitude of the effects we have described so far table 7 presents the marginal effect of the Heckman selection model whose results are in table 6. The marginal effects are computed separately for the probit (i.e. selection into the export market) and export share regression. As it is well known these marginal effects are non-linear in the estimated parameters so the standard errors were computed with the delta method.[23] In brief, from table 7 it possible to see that adding 1 percentage point to the *Hor-Ind-Reg-Exp* and to *Hor-Ind-Reg-Dom* will add to the probability of exporting around *0.037* and *0.012* percentage points. This is equivalent to a rise the probability of exporting by 5 and 1.6 percent, respectively.[24] With regards the export share, adding 1 percentage point to the *Hor-Ind-Reg-Dom* index, will increase the export share by around 0.061 point, which is equivalent to an increment of about *32* percent.[25]

7. Conclusions

Attracting foreign direct investment (FDI) have figured prominently in the agenda of policymakers of developed and developing countries alike. FDI is believed to bring many benefits to host economies, *directly* through, inter alia, increases in employment, research and development (R&D) expenditure, investment, and *indirectly* through externalities (i.e. spillovers). Spillovers from FDI, in particular in terms of productivity, have attracted considerable attention in the empirical and theoretical literature (Gorg and Greenaway 2004). In this exercise, we concentrate on export spillovers using a data set of British

[23] See Greene (2000, pp. 824) for the marginal effects of the selection equation and Greene (2000, pp. 926--933) for the marginal effects of the regression model.
[24] These figures are obtained using the *average* probability of exporting. From the estimates in table 6 the average probability of exporting is P(d = 1| x) = 0.73. Therefore, the changes in the probability of exporting, in percentage terms, are *(0.037/0.73) 100 = 5.07* and *(0.012/0.73) 100 = 1.64*, respectively.
[25] This is computed considering the average export share being 0.19.

manufacturing firms from 1992 to 1999. This is of interest given that one of the prime concerns of economic policymaking has long been that of promoting exports.[26]

Unlike previous empirical studies, we investigate not only horizontal (i.e. *intra-industry*) spillovers, but also vertical externalities (i.e. *inter-industry*). We used Tobit type II model (Hsiao 2003, pp. 229--230) that allows to model the two decisions of whether to export or not and, if so, how much to export, separately. We also differentiate foreign firms in the same industry by their physical proximity to the domestic firm and to their export orientation. Our results indicate that export spillovers are diverse and affect exporters and non-exporters in different fashions.

More specifically, non-exporters seem to benefit only in a limited way from export spillovers. Indeed, the export decision of domestic firms does not seem to be affected by contacts they may have with multinational enterprises. Except for backward spillovers (which are positive and significant) we did not find any evidence of forward and horizontal spillovers.

On the contrary the decision concerning how much to export appear to be influenced by the presence of foreign multinationals in the same, upstream and downstream industries. In addition, *intra-industry* (i.e. horizontal) spillovers seem to depend on the export orientation of foreign firms. Both export oriented and domestic market oriented multinationals appear to generate positive and significant export spillovers, but those from former are stronger. This suggests that of the likely sources of export spillovers, i.e. competition effect from host-market oriented foreign firms and leakage of specific information about foreign market from established foreign exporters, are at work, but the latter is more appears to be more important.

With reference to vertical spillovers, we found negative and significant forward export externalities and positive and significant backward externalities. These results underline that vertical linkages between firms are important for a complete characterisation of the phenomenon of export spillovers. The different sign of backward and forward spillovers is intriguing. This may suggest that these two types of export externalities are different in

[26] Governments undertake several export promotion activities ranging from financing trade fairs, through providing information about foreign markets and financing market researches, to export credit insurance. The rationale of all such initiatives is founded on the belief that exports contribute positively to economic development and productivity.

nature and might have different sources. Further research is needed to investigate them more fully.

Appendix A: Description of variables

Firm - level variables	
Export Share	Ratio between exports and total turnover. Source: OneSource data set
Log of wage	Wage bill divided by the number of employees. Source: OneSource data set
Log of employment	Number of employees. Source: OneSource data set
Log of productivity	Real value added per worker; value added was deflated using detailed producer price indexes (at 3 and 4 digit level). Source: OneSource data set (value added); Office of National Statistics (producer price indexes)
Industry- level variables	
Industry export share	Ratio between industry exports and industry total demand (i.e. industry production plus imports). Source: Yearly Make and Use Input Output tables. Industry Classification: Input-Output Tables industry classification (corresponding roughly to 3 digit sic92 classification)
Industry R and D share	Ratio between industry R&D spending and industry total demand. Source: OECD ANBERD - R&D Expenditure in Industry Vol 2003 release 01 (for R&D expenditure); Make and Use Input Output Tables (for total demand)
Domestic price index	Producer price indexes. Source: Office of National Statistics
Forw	Forward index of spillovers; computed as described in expression 8. Industry classification: Input-Output Tables industry classification
Hor	Horizontal spillover index; computed as described in expression 3. Industry classification: Input-Output Tables industry classification
Hor Exp	Horizontal Export index; computed as described in expression 3 considering the export, only, of foreign firms. Industry classification: Input- Output Tables industry classification
Hor Dom	Horizontal Domestic index; computed as described in expression 3 considering the production of foreign firms sold in the UK, only. Industry classification: Input-Output Tables industry classification
Hor-Ind-Reg	Horizontal Industry Region index; computed as described in expression 4. Industry classification: Input- Output Tables industry classification
Hor-Ind	Horizontal Industry index in different regions; computed as described in expression 5. Industry classification: Input-Output Tables industry classification
Back	Backward index; computed as described in expression 6. Industry classification: Input-Output Tables industry classification

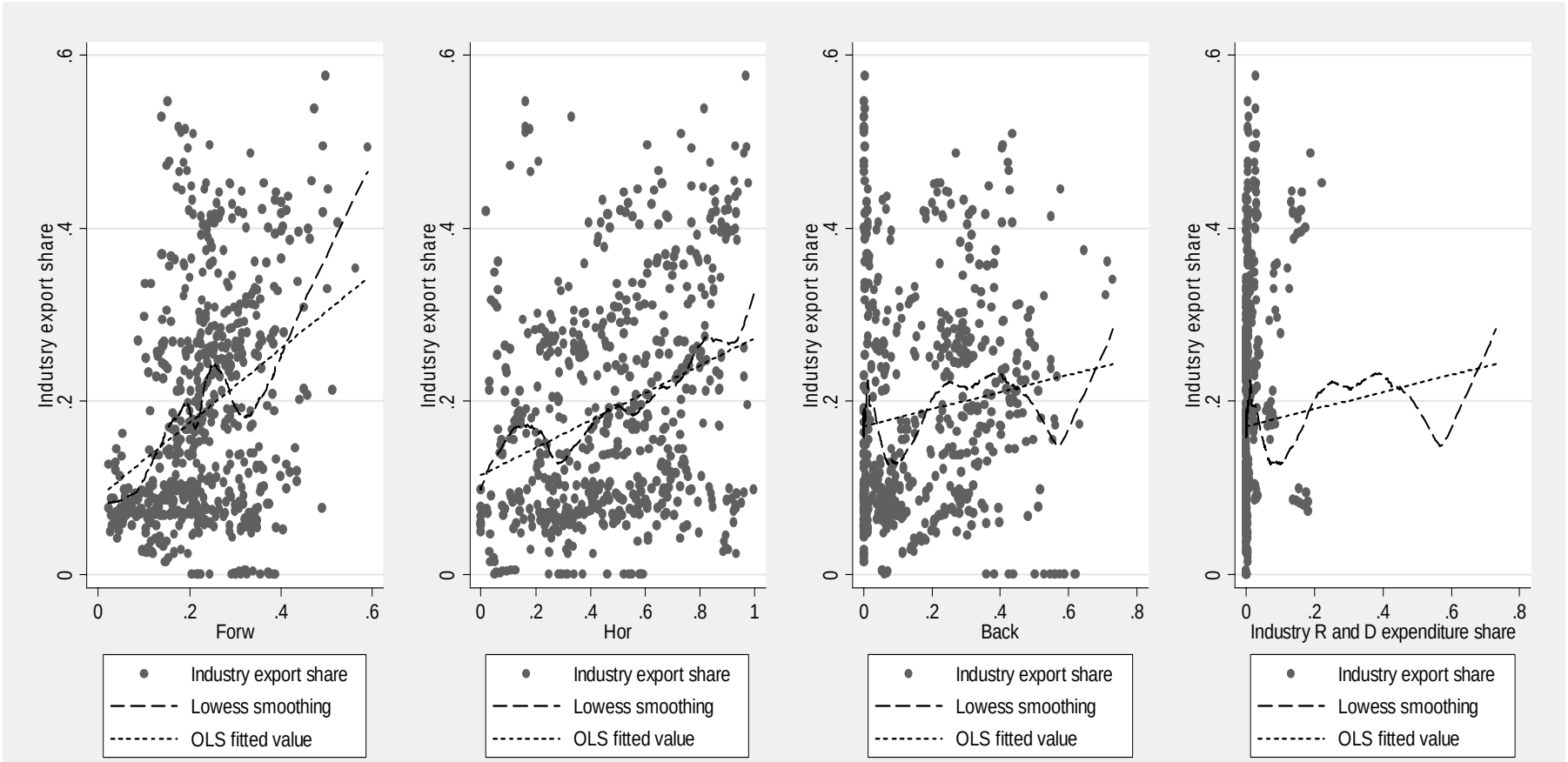
All firm-level variables are computed as difference from the yearly and industry median to take into account time effects and industry characteristics.

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. 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).

Figure 1



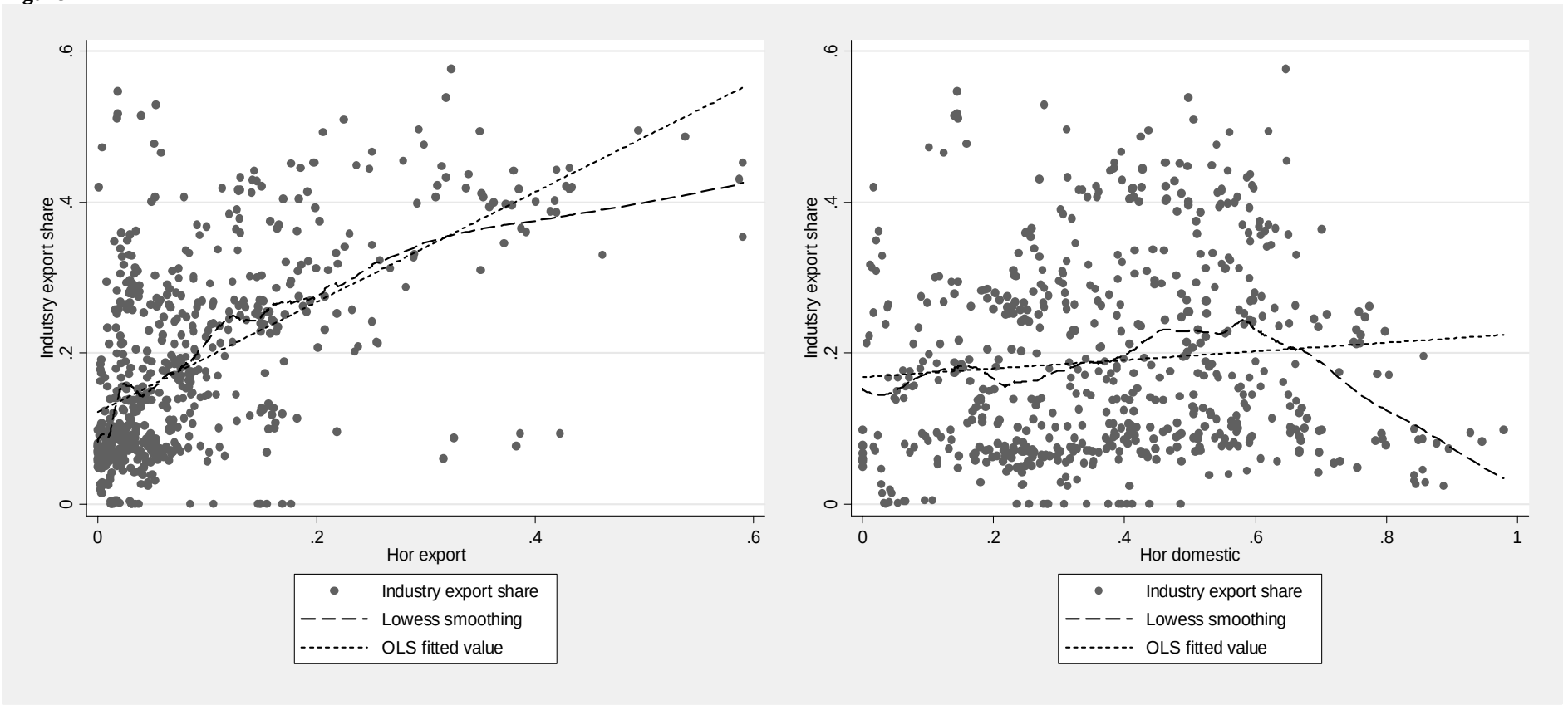
Notes: The lowess smoothing line is the prediction of a non-parametric nearest neighbour regression. This was run setting the number of observation in each neighbour to 2int(α N)+1 where N in the total number of observations and α was set to 0.2. For more details on this method see Johnston and DiNardo (1997, pp. 380--381).

Table 1: Industry export share regression

Forw	0.354
	(0.050)**
Hor	0.084
	(0.020)**
Back	0.069
	(0.032)*
Industry R and D share	0.799
	(0.158)**
Constant	0.043
	(0.015)**
Observations	590
R-squared	0.21

Notes:
(i) Robust standard errors in parentheses
(ii) + significant at 10%; * significant at 5%; ** significant at 1%

Figure 2



Notes: The lowess smoothing line is the prediction of a non-parametric nearest neighbour regression. This was run setting the number of observation in each neighbour to 2int(α N)+1 where N in the total number of observations and α was set to 0.2. For more details on this method see Johnston and DiNardo (1997, pp. 380--381).

Table 2: Industry export share regression

Forw	0.129
	(0.055)*
Hor domestic	-0.071
	(0.019)**
Hor export	0.677
	(0.062)**
Back domestic	0.088
	(0.036)*
Industry R and D share	0.434
	(0.138)**
Constant	0.105
	(0.015)**
Observations	590
R-squared	0.38

Notes:
(i) Robust standard errors in parentheses
(ii) + significant at 10%; * significant at 5%; ** significant at 1%

Table 3: Heckman selection model

	Export Dummy	Export Share
	(1)	(2)
Lag Export dummy	3.174	
	(0.061)**	
Lag log of wage	0.203	0.054
	(0.088)*	(0.024)*
Lag log of wage squared	0.057	0.036
	(0.047)	(0.011)**
Lag log of employment	0.070	-0.001
	(0.019)**	(0.006)
Lag log of employment squared	-0.022	0.003
	(0.012)+	(0.002)
Lag log of productivity	0.077	0.053
	(0.050)	(0.012)**
Lag log of productivity squared	0.017	0.029
	(0.024)	(0.007)**
Industry export share	0.685	-0.022
	(1.292)	(0.148)
Industry R and D share	10.304	0.220
	(6.738)	(0.565)
Domestic price index	1.176	0.179
	(0.661)+	(0.159)
Forw	1.006	0.070
	(0.614)	(0.072)
Hor	0.132	0.055
	(0.294)	(0.032)+
Back	0.330	0.252
	(0.803)	(0.097)**
Constant	1.981	-0.279
	(0.857)*	(0.190)
ρ	-0.317	
	(0.023)**	
λ	-0.070	
	(0.006)**	
Log Likelihood	-1522.500	
Firms	4734	
Observations	19066	

Notes:
(i) Clustered adjusted standard errors in parentheses
(ii) + significant at 10%; * significant at 5%; ** significant at 1%
(iii) ρ is the estimated correlation between the error terms of the two equations; if it is different from zero it suggests that the two equations are related and that the selection model is appropriate; λ is the estimated coefficients of the inverse Mills ratio; if it is different from zero it suggests that there is sample selection.

Table 4: Heckman selection model

	Export Dummy	Export Share
	(1)	(2)
Lag Export dummy	3.175	
	(0.061)**	
Lag log of wage	0.206	0.055
	(0.088)*	(0.024)*
Lag log of wage squared	0.059	0.036
	(0.047)	(0.011)**
Lag log of employment	0.071	-0.001
	(0.019)**	(0.006)
Lag log of employment squared	-0.022	0.003
	(0.012)+	(0.002)
Lag log of productivity	0.076	0.053
	(0.050)	(0.012)**
Lag log of productivity squared	0.017	0.029
	(0.024)	(0.007)**
Industry export share	0.600	-0.022
	(1.191)	(0.145)
Industry R and D share	10.872	0.211
	(7.406)	(0.607)
Domestic price index	1.206	0.181
	(0.656)+	(0.159)
Forw	0.987	0.065
	(0.586)+	(0.069)
Hor-Exp	1.737	0.111
	(0.810)*	(0.079)
Hor-Dom	-0.024	0.047
	(0.309)	(0.036)
Back	0.381	0.257
	(0.806)	(0.096)**
Constant	-8.529	-0.192
	(0.836)**	(0.198)
ρ	0.317	
	(0.023)**	
λ	-0.070	
	(0.006)**	
Log Likelihood	-1520.213	
Firms	4734	
Observations	19066	

Notes:
(i) Clustered adjusted standard errors in parentheses
(ii) + significant at 10%; * significant at 5%; ** significant at 1%
(iii) ρ is the estimated correlation between the error terms of the two equations; if it is different from zero it suggests that the two equations are related and that the selection model is appropriate; λ is the estimated coefficients of the inverse Mills ratio; if it is different from zero it suggests that there is sample selection.

Table 5: Heckman selection model

	Export Dummy	Export Share
	(1)	(2)
Lag Export dummy	3.175	
	(0.060)**	
Lag log of wage	0.198	0.055
	(0.089)*	(0.024)*
Lag log of wage squared	0.055	0.036
	(0.048)	(0.011)**
Lag log of employment	0.073	-0.000
	(0.019)**	(0.006)
Lag log of employment squared	-0.021	0.003
	(0.012)+	(0.002)
Lag log of productivity	0.079	0.053
	(0.050)	(0.012)**
Lag log of productivity squared	0.017	0.029
	(0.024)	(0.007)**
Industry export share	0.763	-0.017
	(1.295)	(0.145)
Industry R and D share	10.551	0.401
	(6.759)	(0.585)
Domestic price index	1.127	0.176
	(0.652)+	(0.155)
Forw	1.006	0.058
	(0.610)+	(0.071)
Hor industry-region	0.197	0.036
	(0.074)**	(0.020)+
Hor industry	0.034	0.066
	(0.240)	(0.039)+
Back	0.341	0.258
	(0.824)	(0.095)**
Constant	-8.651	-0.222
	(0.764)**	(0.183)
ρ	0.318	
	(0.023)**	
λ	-0.070	
	(0.006)**	
Log Likelihood	-1509.883	
Firms	4734	
Observations	19066	

Notes:
(i) Clustered adjusted standard errors in parentheses
(ii) + significant at 10%; * significant at 5%; ** significant at 1%
(iii) ρ is the estimated correlation between the error terms of the two equations; if it is different from zero it suggests that the two equations are related and that the selection model is appropriate; λ is the estimated coefficients of the inverse Mills ratio; if it is different from zero it suggests that there is sample selection.

Table 6: Heckman selection model

	Export Dummy	Export Share
	(1)	(2)
Lag Export dummy	3.176	
	(0.061)**	
Lag log of wage	0.200	0.055
	(0.089)*	(0.024)*
Lag log of wage squared	0.056	0.036
	(0.048)	(0.011)**
Lag log of employment	0.073	-0.000
	(0.019)**	(0.006)
Lag log of employment squared	-0.021	0.003
	(0.012)+	(0.002)
Lag log of productivity	0.079	0.054
	(0.050)	(0.012)**
Lag log of productivity squared	0.017	0.029
	(0.024)	(0.007)**
Industry export share	0.745	-0.008
	(1.254)	(0.140)
Industry R and D share	10.776	0.377
	(6.929)	(0.660)
Domestic price index	1.145	0.172
	(0.653)+	(0.154)
Forw	0.968	0.051
	(0.591)	(0.071)
Hor industry-region exp	0.453	-0.036
	(0.265)+	(0.044)
Hor industry-region dom	0.148	0.057
	(0.082)+	(0.022)**
Hor industry exp	0.705	0.156
	(0.629)	(0.081)+
Hor industry dom	-0.041	0.053
	(0.256)	(0.042)
Back	0.348	0.267
	(0.820)	(0.093)**
Constant	-8.738	-0.268
	(0.775)**	(0.186)
ρ	0.318	
	(0.023)**	
λ	-0.070	
	(0.006)**	
Log Likelihood	-1495.351	
Firms	4734	
Observations	19066	

Notes:
(i) Clustered adjusted standard errors in parentheses
(ii) + significant at 10%; * significant at 5%; ** significant at 1%
(iii) ρ is the estimated correlation between the error terms of the two equations; if it is different from zero it suggests that the two equations are related and that the selection model is appropriate; λ is the estimated coefficients of the inverse Mills ratio; if it is different from zero it suggests that there is sample selection.

Table 7: Marginal effect of the Heckman selection model of table 6

	Export Dummy	Export Share
	(1)	(2)
Lag Export dummy	0.497	
	(0.012)**	
Lag log of wage	0.016	0.059
	(0.007)*	(0.024)*
Lag log of wage squared	0.005	0.038
	(0.004)	(0.012)**
Lag log of employment	0.006	0.001
	(0.002)**	(0.006)
Lag log of employment squared	-0.002	0.003
	(0.001)+	(0.002)
Lag log of productivity	0.006	0.055
	(0.004)	(0.012)**
Lag log of productivity squared	0.001	0.029
	(0.002)	(0.007)**
Industry export share	0.060	0.008
	(0.101)	(0.144)
Industry R and D share	0.871	0.619
	(0.560)	(0.703)
Domestic price index	0.138	0.198
	(0.120)	(0.165)
Forw	0.078	0.072
	(0.047)+	(0.074)
Hor industry-region exp	0.037	-0.025
	(0.021)+	(0.046)
Hor industry-region dom	0.012	0.061
	(0.007)+	(0.022)**
Hor industry exp	0.057	0.172
	(0.050)	(0.074)*
Hor industry dom	-0.003	0.052
	(0.021)	(0.044)
Back	0.028	0.275
	(0.066)	(0.104)**

Notes:
(i) + significant at 10%; * significant at 5%; ** significant at 1%
(ii) Standard errors have been computed with the delta method.

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