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Are there Regional Spillovers from FDI in the UK?

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Abstract:
This paper examines whether spillovers from foreign to domestic firms occur at the level of the region. We estimate the total factor productivity of domestic firms in the UK, including indicators for the level of FDI in the region and sector; in the sector but outside the region; and in the region but outside the sector. In addition, we also check to see if the characteristics of the firm and sector influence the level of spillovers from foreign firms. We conclude that domestic firms gain from the presence of multinational firms in the same sector and region, but loose out if the firms are located in a different region but the same sector. The characteristics of the region and sector also influence the level of spillovers. Less-developed regions gain less from spillovers than other regions, sectors with high levels of competition gain more, and sectors with a low technology gap between foreign and domestic firms experience higher spillovers.

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1. Introduction

One of the aims of attracting FDI to the UK through incentives is to improve regional development. Having firms locate in under-developed regions will provide a direct impact in terms of employment and capital creation – assuming there were under-utilised resources prior to entry – and a potential indirect effect via spillovers to local firms. A recent example of such intervention is the aid package given to Siemens to locate in the North East of England; an underdeveloped region with Assisted Area status. State investment included a $30 million grant, which along with other benefits totalled $76 million (UNCTAD, 1996). The assumption behind such packages is that the long-term economic impact on the region will exceed the cost of the subsidies. We aim to examine whether spillovers from foreign to domestic firms occur at the level of the region. We look at whether domestic firms gain from foreign firms only if they locate in the same region, or whether all firms in a sector gain regardless of location.

Examining the evidence for spillovers is important, as it is the existence of spillovers i.e. benefits for which the receiving firm does not pay the full price, which provides the rationale for government incentives. If spillovers occur, then the social rate of return to an investment will exceed the private rate of return, justifying government intervention. Such incentives are allowed under EU competition regulations when the aim is to promote economic development in underdeveloped regions (with some restrictions). In addition, assessing the level of spillovers is one way of judging the level of technology transfer from MNEs, a topic that has received much attention from both economists and policy makers. The evidence relating to the existence and extent of spillovers is mixed. Aggregate empirical evidence for the UK (Barrell and Pain, 1997) indicates that spillovers may be an important source of productivity improvements in the UK. In contrast, Girma, Greenaway and Wakelin (2000) find no evidence of national *intra-sectoral* spillovers using firm-level data, although more detailed analysis indicated that some firms gain while others loose from the presence of foreign firms in the same sector. We wish to extend that work by adding a regional dimension.

Some studies have explicitly concentrated on regional spillovers, but to our knowledge, this is the first UK study using firm-level data. Firm data allow us to control for sector characteristics that may influence spillovers. We also explicitly take account of other features, including the source country of FDI, the level of competition in the sector and the role of incentives in influencing the level of spillovers from FDI.

The structure of the paper is as follows. Section 2 gives a summary of why we would expect regional spillovers. Section 3 sets out the model to be estimated and gives some information on the data set used. Section 4 outlines the results. Section 5 briefly concludes.

2. Regional spillovers from FDI

The theoretical basis for the expectation of spillovers from foreign firms is the level of firm-specific assets that MNEs are assumed to have in order to overcome the higher costs they face in foreign markets (Hymer, 1976; Dunning, 1977). These higher costs arise as the foreign firm is unfamiliar with the market, demand characteristics, supplier links etc. that are known to the domestic firm. These firm-specific assets are often of a technological nature – more than 80% of royalty payments for international technology transfers were made by affiliates to their parent companies (UNCTAD, 1997). They also have public-good characteristics: excluding other (in this case local) firms from obtaining the knowledge can be difficult. The empirical evidence as to the actual extent of spillovers from MNEs is mixed (Blomström and Kokko, 1996; Blomstöm *et al*. 1999); the evidence for a productivity differential between foreign and domestic firms in favour of MNEs is more convincing (Girma *et al*., 2000; Djankov and Hoekman, 2000).

Why would spillovers have a regional dimension i.e. why would firms geographically close to MNEs particularly benefit from their presence? There are a number of possible explanations. First, direct contacts with local suppliers and distributors i.e. upward and downward linkages may be local in nature in order to minimise transport costs and facilitate communication between the supplier/distributor and the MNE. Second, the training of employees by MNEs and subsequent turnover of labour is another avenue for spillovers (Haacker, 1999). As regional labour mobility is extremely low (Greenaway *et al*., 2000), many of the benefits in terms of a better skilled workforce with tacit technical knowledge gained from MNEs will be experienced by local employers. Third, demonstration effects may also be local if firms only closely observe and imitate other firms in the same region (Blomström and Kokko, 1996). Fourth, knowledge flows may be regional in character. Jaffe *et al*. (1993) have found that knowledge flows in the US have a regional component. The spread of new ideas is most intense in the area close to the innovation. These factors may lead to significant regional benefits from spillovers.

An alternative hypothesis is that if MNEs locate in less-developed regions to take advantage of subsidies, spillovers may be reduced, as local firms in these areas do not have the technological capacity to benefit from the MNEs. There is some evidence that a certain level of technological ability or ‘absorptive capacity’ (Cohen and Levinthal, 1989) is needed for domestic firms to benefit from MNEs (Girma *et al*., 2000; Aitken and Harrison, 1999). Spillovers may be maximised by allowing MNEs to choose locations according to location advantages rather than influencing that choice through incentives. This would indicate that spillovers were lower in regions that have been subject to such incentives.

Within the EU, government assistance to industry is limited by the European Commission under competition regulations first set up under the Treaty of Rome (UNCTAD, 1996). These regulations apply to aid offered to both domestic and foreign firms. One of the main exceptions to these regulations is through aid to promote development in underdeveloped regions (termed Assisted Area status in the UK). Such regional exceptions explain 50% of aid to manufacturing granted within the European Union in 1996 (UNCTAD, 1996). Even with this form of assistance there are regional ceilings to the level of aid; in the UK these vary between 20% and 30%. There is some evidence (Wren and Taylor, 1999) that these regional incentives have had an impact on UK industrial structure[1]. In particular, there is evidence that such incentives influence the choice of location of MNEs within a country (see for instance Head *et al*., 1999 for the US).

In the UK, Taylor (1993) indicates that the Assisted Area status of a county was a significant predictor for the level of Japanese investment in that county. Only 24% of Japanese manufacturing affiliates (up to 1992) have chosen to locate in UK regions without Assisted-Area status. A counter-factual estimation indicated that around two thirds of the location choices were influenced by a region having Assisted Area status (Taylor, 1993). This may have reduced the potential for spillovers from MNEs as they are located in regions with low absorptive capacity.

So far we have concentrated on positive spillovers from MNEs, however, spillovers may also be negative if they increase competition in the sector. Aitken and Harrison (1999) found that increased FDI lowered the productivity of domestic-owned firms in Venezuela, presumably as a result of increased competition. Through superior technology and economies of scale MNEs may be able to produce lower down their average cost curve increasing competition for domestic firms. At the most extreme, indigenous firms may leave the market as a result of increased competition from MNEs. Girma *et al* (2000) also found that some firms lost out as a result of MNEs presence in the UK. In particular, firms located in low-skill sectors, with low levels of import competition and a large technology gap between the domestic and foreign firms experienced negative spillovers.

At the regional level, Driffield (1999) has examined the role of productivity spillovers from inward investment in the UK using sector-level data. The data set covers 10 regions, 20 manufacturing sectors and` a period from 1984-1992. The results indicate that there are positive productivity spillovers from FDI in the same sector and region, and more generally at the regional level, but that these effects are small. FDI in the sector as a whole (but not in the region) actually has a negative impact on

[1] See Young *et al*. (1994) for a review of the impact of FDI on regional development and Gillespie *et al*. (1999) for a regional computable general equilibrium analysis of the impact of FDI on the Scottish economy.

productivity. This is assumed to be because of the increased competition at the sector level.

In contrast, Sjöholm (1998), using firm-level data for Indonesia, finds evidence of *intra-industry* spillovers at the national level, but *not* at the level of the province or the district. He interprets this as indicating there are no extra benefits from being geographically close to foreign firms. He does however, find some evidence for *inter-industry* spillovers at the regional level. This gives some support for the idea of local linkages to neighbouring sectors. Atiken and Harrison (1999) test to see if spillovers are local in the case of Venezuela. They find no significant impact of region and sector-specific FDI on domestic firms' productivity. They conclude that there is no regional element to spillovers. In fact, the only evidence of spillovers they find is to firms that are partly foreign owned (i.e. in joint ventures), wholly domestic firms experience negative spillovers from FDI at the national level[2].

A number of firm and sector characteristics have been suggested as possible influences on the level of spillovers (Blomstöm *et al*. 1999; Sjöholm, 1999). Domestic firms with low levels of technology may not be able to benefit from spillovers as they lack the necessary absorptive capacity (Lapan and Bardhan, 1973). This may also be the case for small domestic firms that cannot compete in terms of economies of scale (Dunning, 1993) and as a result may experience negative spillovers from MNEs. Competition has also been suggested as an important influence on the extent of spillovers. MNEs may need to bring more advanced technology to the host country when competition in that country is high, increasing the possibility of spillovers (Blomstöm *et al*. 1999). Some of these hypotheses have found confirmation at a national level (Girma *et al*., 2000; Kokko 1994). Both studies found the degree of spillovers from FDI to increase as the technology gap between foreign and domestic firms *decreased*. The results cover both developing and developed countries: the former study is for the UK and the latter for Mexico. In contrast, Sjöholm, 1999 found some evidence that *sectors* characterised by large technology gaps between foreign and domestic firms gained more from the foreign presence than sectors with smaller gaps in Indonesia. He also found a positive relationship between competition at the sector level and spillovers from FDI confirmed by Kokko (1994). We also test to see if these characteristics are important at the regional level.

The existing literature highlights a number of hypotheses that we investigate in our econometric analysis:

- Are spillovers from multinationals to domestic firms larger when the MNE is located in the same region (as well as the same sector) as the domestic firm? Or is it only the sector in which the MNE is located that is important?

[2] There is some evidence that high levels of regional FDI increased skilled wages for Mexico in the 1980s (Feenstra and Hanson, 1997).

- Does the nationality of the MNE influence the level of spillovers to domestic firms?
- Do the characteristics of the domestic firm and sector influence the level of spillovers? Characteristics include the level of intangible assets of the firm and the competition in the sector.
- Does the presence of government incentives to locate in the region influence the impact of spillovers?

The next section will outline how these hypotheses will be tested in an econometric model.

3. The Model

In order to identify the role of FDI in firm productivity, we estimate total factor productivity equations for our sample of firms including additional terms to account for the level of FDI in the sector and region. As we measure the impact of spillovers on total factor productivity, measures for both labour and capital employed at the firm level are included. The relationship to be estimated is given by:

$$Q_{it} = f(L_{it}, K_{it}, FDI1_{srt}, FDI2_{st}, FDI3_{srt}, FDI1_{srt}*X) \quad (1)$$

Where:

Q_{it} log of output in firm i at time t;

L_{it} log of employment in firm *i* at time *t*;

K_{it} log of fixed assets in firm *i* at time *t*;

$FDI1_{st}$ the level of employment by foreign affiliates in each firm's four-digit sector *s* and in the same region *r* at time *t*;

$FDI2_{st}$ the level of employment by foreign affiliates in each firm's four-digit sector *s* outside it's own region *r* at time *t*;

$FDI3_{srt}$ the level of employment by foreign affiliates in each firm's two-digit sector *s* in the firm's region *r*, less FDI1 at time *t*.

X is a vector of firm and sector characteristics including at time *t*:

$ASSETS_{it}$ the level of intangible assets in firm *i* relative to employment;

$CONC_{srt}$ the Herfindhal concentration index for the four-digit sector *s* in the region *r*; as concentration increases, we assume competition in the sector is reduced;

AA_r a dummy variable taking the value of one if a region *r* has Assisted Area status.

The three FDI variables are designed to capture spillover effects from within the industry and the same region (FDI1), from outside the region but within the sector (FDI2) and from neighbouring sectors in the same region (FDI3). Neighbouring sectors are defined as those not in the same detailed 4-digit classification as the firm, but who form part of the wider 2-digit definition. The first two variables measure intra-sectoral spillovers, while the third is inter-sectoral. FDI1 and FDI3 both represent spillover sources within the region, while FDI2 is outside. If regional spillovers from FDI within the sector are important, we would expect FDI1 to be significant, from outside the sector FDI3 is the relevant variable. As discussed earlier, spillovers can be either negative or positive.

In order to check the role of firm and sector characteristics, FDI is also interacted with a number of characteristics. We expect FDI interacted with concentration to have a negative impact on firm output: firms in less competitive i.e. highly concentrated sectors will benefit less from spillovers as MNEs bring less technology with them reducing the potential for spillovers. We expect the firm-specific assets of the domestic firm (measured by intangible assets of the firm ASSETS) to increase the possible spillovers from foreign firms as it proxies the absorptive capacity of the firm. Finally, we expect regions that have Assisted-Area status to benefit less from spillovers than other regions, as attracting FDI through incentives may reduce the potential benefits from MNEs.

We estimate possible productivity spillovers using the following equation:

$$\begin{aligned} y_{it} = {} & \delta_1 FDI1_{srt} + \delta_2 FDI2_{st} + \delta_3 FDI3_{srt} + \delta_4 FDI1_{srt} * AA_r \\ & + \delta_5 FDI1_{srt} * CONC_{srt} + \delta_6 FDI1_{srt} * ASSETS_{it} + \beta_1 L_{it} + \beta_2 K_{it} \\ & + D_{sic} + D_i + D_r + \varepsilon_{it} \end{aligned} \qquad (2)$$

Where *i* and *t* index firms and years respectively and *s* and *r* sector and region; D_{sic} is a four-digit SIC92 dummy for fixed industry effects. D_t are time dummies that account for aggregate shocks. D_r are regional dummy variables, they account for agglomeration effects at the regional level. Some regions may have particular advantages that attract firms to those areas, in order to take account of those factors we have included these dummy variables. ε denotes a possible heteroscedastic random noise term with unrestricted (within-firm) serial correlation structure. The dependent variable y is the log of output and L and K are labour and capital respectively. All the FDI terms are as described earlier. Exact definitions of the variables are given in the Appendix.

The regressions are run on data for domestic firms alone. Since industry fixed effects are included, we are only exploiting within-sector variations. If the regressions were run without the industry dummies, we would have been able to exploit the between sector FDI variations as well. However, with that modelling framework a positive

coefficient on the FDI variable can simply reflect the fact that foreign firms invest in industries that pay higher wages and enjoy higher productivity rather than the existence of any genuine spillovers to domestic firms, i.e. there is a sector selection problem. This is the same at the regional level explaining why we have also included regional dummy variables.

3.1 Database construction and sample characteristics

We use a large firm-level panel data set of over 3700 domestic in UK manufacturing for the period 1988-96[3]. The data set is highly disaggregated and there are no reasons for supposing the period is in any way unrepresentative. The primary source of information on firms is the *OneSource* database of private and public companies. Firms are defined as foreign if the country of origin of their ultimate holding company is not the UK; these are not included in the estimations but are rather used to assess the level of FDI in the sector.[4] Only domestic firms are included as we wish to estimate the spillovers to these firms.

This data set has a number of attractions. First it covers a recent period. Second, we use highly disaggregated price deflators (at the five digit SIC 92 level) which allow us to avoid many of the problems associated with more aggregate price deflators. Third we have been able to match firm-level data with industry variables such as concentration. Finally, the use of a firm-level data set mitigates aggregation biases by allowing us to control for a number of observable and unobservable firm-level characteristics.

We have a number of criteria for selecting our sample. First, we chose domestic *subsidiaries* that have not experienced a change of ownership between 1988 and 1996. Subsidiaries are chosen as parent companies may have consolidated accounts leading to double counting. In addition, recent work on the impact of acquisition on wages and productivity (Conyon, Girma, Thompson and Wright, 1999) found that acquisition by a foreign firm leads to higher productivity and wages. We wish to abstract from this, by concentrating on affiliates that have not experienced a change in ownership over the period. Second, the resulting firms are screened for data availability on wages, employment, value added and fixed assets; firms are included if they have at least three consecutive years of data. Third, to mitigate the impact of outliers we excluded the top and bottom 5 percentile firms in terms of value added and wages. We also excluded firms with annual wages or value-added growth exceeding 100%, as we have doubts about the reliability of these extreme data points. This leaves us with a panel of 3,749 domestic affiliates.

[3] We have price deflators for the five-digit sectors based on the 1992 Standard Industrial Classification.
[4] In cases where the ultimate holding company is not known, the country of origin of the holding company it used. We do not know the extent of foreign ownership within the firm, but evidence indicates that is it not an important influence on spillovers (Blomstöm and Sjöholm, 1999).

For the analysis we divide firms into fourteen regions. Clearly the choice of a 'region' is always fairly arbitrary. We have chosen this division partly for reasons of tractability, but also because it corresponds to areas with definite regional identities[5]. Summary statistics are provided for those 14 regions in Table 1 for all manufacturing industry. A star designates a region with Assisted-Area status[6].

Table 1: Summary statistics – regional means and deviations

Region * AA status	**Employment**	**Wages (£ '000)**	**Output/ Employment (£m)**	**MNEs (no.)**	**MNE share of emp. (%)**
Central London	254 (455)	16.6 (4.9)	21.3 (42.9)	478	21.8
Central South	198 (341)	15.8 (4.2)	15.1 (39.7)	447	46.2
East Anglia	160 (306)	15.0 (4.0)	11.7 (23.2)	212	55.7
East Midlands	212 (289)	13.6 (3.9)	11.7 (17.9)	278	28.6
Home Counties	168 (243)	16.2 (4.2)	11.9 (20.1)	126	63.2
North East *	239 (345)	14.2 (3.8)	16.1 (27.4)	494	29.4
North Scotland *	115 (126)	12.8 (4.6)	11.2 (25.5)	22	45.6
North West *	191 (316)	14.1 (3.9)	13.2 (24.2)	470	28.3
Outer London	204 (374)	17.0 (4.7)	20.5 (64.6)	213	26.3
South East	140 (196)	15.5 (4.0)	8.9 (15.6)	146	41.0
South West	124 (149)	14.5 (3.7)	8.5 (12.7)	91	36.3
South Scotland *	236 (356)	13.8 (3.9)	14.6 (22.6)	128	23.1
Wales *	164 (234)	14.3 (3.7)	13.6 (40.2)	100	37.6
West Midlands *	219 (305)	13.9 (3.6)	13.9 (24.8)	544	38.0

Employment, wages and labour productivity are averages over all the firms in the region and over time. MNE share of employment is measured as the level of multinational employment in the sector and region over the sector and region total averaged over time

As can be seen from Table 1, wages and average employment by firm do show some variation across regions. The lowest average wages are seen in Scotland and the Midlands (both East and West) while the highest are in Central and Outer London. In terms of average firm size, the lowest average seems to be in rural areas (North of Scotland, East Anglia) and highest in industrial areas (South of Scotland, West Midlands), reflecting industrial structure in those regions. There is also considerable variation in labour productivity, with particularly high rates found in the two London regions and low labour productivity in the South East and South West. As the high standard deviations indicate, there is also a great deal of variation within regions as well as between them. The distribution of multinational companies across regions is also very uneven. The highest share of foreign-owned firms in employment is in the

[5] Northern Ireland is not included in our database.

[6] For part of the period the West Midlands was classified as an Intermediate Area. However, this separation was removed. We have treated it as an Assisted Area.

south – the Home Counties, East Anglia and Central South. The lowest foreign share (for manufacturing, obviously it would be high in services) is in Central London followed by South Scotland.

4. Results

The results after estimating Equation (2) are given in the second column of Table 2. In order to test if the country of origin of the FDI is important, a second estimation with FDI divided nationality is also included. FDI is divided into that originating from the US, Japan and 'other'. The last category is mostly made up of FDI from other European countries such as Germany and the Netherlands. These results are presented in the third column of Table 2. Regional and sectoral dummy variables are not reported.

Table 2: The Basic Model

Dependent variable: log of output

	Total FDI	**FDI by nationality**
Capital	0.17 (19.28) ***	0.17 (19.26) ***
Labour	0.79 (65.77) ***	0.79 (65.89) ***
FDI1	0.14 (2.47) ***	
FDI2	-0.13 (2.15) **	-0.13 (2.14) **
FDI3	0.04 (0.73)	0.05 (0.76)
FDI*ASSETS	0.008 (1.37)	0.008 (1.37)
FDI*CONC	-0.24 (2.51) ***	-0.24 (2.57) ***
FDI*AA	-0.14 (2.36) ***	
FDI1 USA		0.14 (2.04) **
FDI1 USA * AA		-0.18 (2.11) **
FDI1 Japan		0.33 (2.10) **
FDI1 Japan * AA		-0.19 (0.51)
FDI1 Other		0.12 (1.83) *
FDI1 Other *AA		-0.09 (1.22)
Adjusted R^2	0.85	0.85
N	23,756	23,756
F (26, 23,557)	780.21***	685.3***

*T-statistics are given in brackets; they are calculated with robust standard errors. *** indicates significant at 1%; ** at 5% and * at 10%.*

The results indicate that there is a regional spillover effect from having multinationals locate in the same sector and same region as the domestic firm (FDI1). It has a positive effect on output after controlling for capital and labour inputs. This positive effect is mitigated, as we expected, if the FDI is located in a region with Assisted-Area status (FDI1*AA). In the case of assisted areas the impact of FDI in the same sector and region is negligible. This may be that MNEs have been attracted to those sectors by incentives rather than location advantages, and that local firms do not have the absorptive capacity to benefit from spillovers. FDI in the same sector and region also has much less of an impact in sectors with low levels of competition.

Higher levels of CONC indicate high concentration, implying low levels of competition in the sector and region; this is negatively related to spillovers from FDI. This confirms that sectors with high competition benefit more from foreign firms. This may be because the foreign firms introduce better technology as a result of the level of competition in the sector, increasing the potential for spillovers. The level of intangible assets of a firm (taken as a proxy for its own firm-specific assets, and therefore its ability to absorb new technologies) has the expected positive sign but is not significant. Overall, FDI has a positive impact at the regional level, but this effect is reduced in sectors with low competition and with Assisted-Area status.

Other measures of FDI are also included. FDI2 is FDI in the same sector but outside the region has a negative impact on output. This implies a negative competition spillover, with foreign firms raising the level of competition in the sector. This confirms other results for the UK (Driffield, 1999) but is in contrast to evidence for developing countries (Sjöholm, 1998; Aitken and Harrison, 1999). The last two papers either found negligible or positive spillovers at the sector level, but no regional dimension. It appears that there is a more *regional* dimension to spillovers in industrialised than developing countries. This negative sectoral effect does not seem to be compensated for by any positive learning effects unless the FDI takes place in the region as well as the sector. FDI in the region but outside the immediate sector (FDI3) has no significant impact.

When the positive region and sector-specific effect is broken down by nationality, the results are very similar across countries. FDI from Japan has a higher coefficient than FDI from either of the other two, indicating that the magnitude of the regional spillover is higher in the case of Japanese affiliates in the UK. The negative effect observed for FDI attracted to areas eligible for regional assistance seems to be due to US-owned firms rather than FDI from either of the other two categories. In the case of both FDI from Japan and from other countries no significant effect is found. However, US firms that locate in regions with Assisted-Area status do seem to be associated with lower spillovers to domestic firms. Thus although Japanese firms appear to be attracted to less-developed regions (Taylor, 1993), this does not seem to reduce the level of spillovers from them to domestic firms.

Overall, the results confirm that spillovers seem to have a regional dimension. Domestic firms appear to gain only from firms locating in the same sector and region as them, while they simultaneously loose out from foreign firms locating in the same sector but not the same region. Positive information and demonstration spillovers appear to have a regional dimension, while negative competition effects are limited to the sector. Foreign firms locating in the wider 2-digit sector in the same region appear to have no impact on productivity.

One of the hypotheses that we particularly wanted to investigate is if firms with a large technology gap benefit more or less from the presence of foreign firms. In order to test this we split domestic sectors into three groups. First we calculate total factor productivity at the 2-digit level separately for domestic and foreign firms in each sector. Then we measure the technology gap between foreign and domestic firms by:

Where *s* indicates the sector, *f* foreign firms, *d* domestic and TFP is total factor

$$GAP_s = \frac{TFP_{fs} - TFP_{ds}}{TFP_{fs}}$$

productivity growth. We then split the domestic firms according to three groups:

- Low gap: those with a small gap between domestic and foreign firms in the sector (GAP is less than 15%);
- Medium gap: those with a gap between 15% and 33% from foreign firms;
- High gap: when the gap from foreign firms is over 33%.

Using this separation we repeat the basic model estimated in Table 2 for the three groups of firms. If firms closer to the technological frontier benefit more, we would expect to see significant spillovers for the group with a low gap, rather than for the other two groups. The results are given in Table 3.

Table 3: Results split by technology gap

	Low gap	**Medium gap**	**High Gap**
Capital	0.17 (13.4) ***	0.16 (16.6) ***	0.16 (10.2) ***
Labour	0.77 (44.5) ***	0.80 (58.9 ***	0.82 (36.1) ***
FDI1	0.18 (0.07) ***	0.13 (1.62)	0.10 (0.78)
FDI2	-0.18 (0.09) **	-0.11 (1.24)	-0.16 (1.12)
FDI3	0.13 (1.59)	-0.06 (0.82)	0.18 (1.39)
FDI1*ASSETS	0.005 (0.59)	0.02 (3.75) ***	0.001 (0.26)
FDI1*CONC	-0.40 (3.42) ***	-0.16 (1.19)	-0.21 (1.01)
FDI1*AA	-0.17 (2.40) ***	-0.13 (1.72) *	-0.07 (0.58)
Adjusted R^2	0.84	0.85	0.85
N	9,770	10,657	3,317
F	421.9***	607.1***	206.1***

*T-statistics are given in brackets; they are calculated with robust standard errors. *** indicates significant at 1%; ** at 5% and * at 10%.*

It is clear from the results that the regional spillover variable FDI1 is only significant for the firms in sectors with a low technology gap between foreign and domestic firms. It is only in sectors in which domestic firms do not lag far behind foreign that positive spillovers are experienced. This confirms that domestic firms find it easier to learn from foreign firms when the technological gap between them is relatively small. As this gap increases domestic firms may find it harder to adopt the new technology

brought by the foreign firms. However, it is only for firms in sectors with small technology gaps that experience negative spillovers from MNEs. The increased competition at the sector level (see the results for FDI2) appears to be more intense in sectors where the domestic firms lag only slightly behind the foreign firms. This negative effect is also insignificant for the other two groups of firms. Therefore, domestic firms that do not lag behind experience both positive spillovers – from foreign firms in the same sector and region – and negative spillovers at the sector level. FDI from outside the immediate sector but inside the region remains insignificant for all groups.

Interestingly the interaction between a firm's intangible assets and FDI is significant only for the medium group. It may be that all firms in the low-gap group have high levels of intangible assets, so the marginal effect is small. However, in the medium group having intangible assets may distinguish one firm from others in the sector. Firms with high intangible assets in this group seem to benefit more from spillovers than other firms in the sector.

The competition result is again significant only for the group with the low gap. Indicating that among those sectors with low technology gaps, those that have high levels of competition still have higher spillovers. The level of competition has no significant influence in the other two groups of sectors.

Regions with Assisted-Area status still appear to have lower spillovers for both firms in sectors with low and medium technology gaps. It is only those firms with high technology gaps that have no significant effect. For firms with medium to low technology gaps spillovers are still lower in regions that offer financial incentives to locate there.

5. Conclusions

Summarising our results, we do find evidence that positive spillovers from foreign firms occur only to domestic firms in the same sector and region as the foreign firms. We also find some evidence of negative spillovers at the sector level but outside the region. There clearly does seem to be a regional channel for spillovers – this may be through linkages to other firms, local information and demonstration effects or through the local labour market. The size of these spillovers varied only slightly over nationality, with larger local spillovers from Japanese firms.

We also found evidence that the characteristics of sectors and firms are important in influencing spillovers. Sectors with high levels of competition and in regions without Assisted-Area status gained more from the presence of foreign firms. It seems that attracting FDI through regional incentives may actually reduce the level of spillovers resulting from their location in the UK. However, using a dummy variable for

Assisted Area status is a relatively crude way of measuring this effect. In future work we hope to use a more precise estimate for the level of regional incentives. However, these firms also experience more negative spillovers at the sector level. Thus domestic firms that are themselves characterised by relatively high firm-specific assets do not appear to be immune from the competitive effects of MNEs in the sector.

It also seems to be the case that domestic firms located in sectors characterised by low technology gaps between foreign and domestic firms gain more from spillovers. This is consistent with the idea that a certain level of absorptive capacity is needed in order to benefit from the superior technology introduces by many foreign firms.

To conclude, the expectation of regional spillovers from foreign to domestic firms appears reasonable. However, there is some evidence that in less-developed regions (i.e. those with Assisted Area status) the spillovers from foreign firms are lower than in other regions. This may partly be because other firms in those regions do not have the necessary knowledge and skills to benefit from the presence of foreign firms. Ironically, regional policies to attract FDI may limit exactly what they wish to attract.

Data appendix

Output: total sales by the firm in the year (OneSource).

Employment: Average number of employees during the year including full time and part-time workers (OneSource).

Wages: Average remuneration paid to employees in a year excluding tax, social security and pension payments (OneSource).

Fixed assets: Tangible fixed assets at their net book values (OneSource).

Producer Price Indices: Five-digit SIC92 level indices obtained from The Business Monitor MM 22.

FDI: The presence of foreign direct investment is estimated by the foreign share of manufacturing employment either at the level of the sector or region. These are calculated by considering the population of subsidiaries in OneSource.

CONC: Herfindhal index for each sector and region (calculated from OneSource).

ASSETS: real intangible assets in the firm (OneSource).

AA: 1 if a region has Assisted Area status (taken from the DTI website).

References

Aitken, B. J. and Harrison, A. E. (1999) Do domestic firms benefit from direct foreign investment? Evidence from Venezuela, *American Economic Review*, 89, pp. 605-18.

Barrell, R. and N. Pain (1997) Foreign direct investment, technological change and economic growth within Europe, *Economic Journal*, 107, pp. 1770-86.

Blomström, M and Kokko, A (1996) Multinational corporations and spillovers, *Stockholm School of Economics Working Paper Series in Economics and Finance* no. 99.

Blomström, M. and F. Sjöholm (1999) Technology transfer and spillovers: does local participation with multinationals matter? *European Economic Review*, 43, pp. 915-23.

Blomström, M, S. Globerman and A. Kokko (1999) The determinants of host country spillovers from foreign direct investment: review and synthesis of the literature, paper presented at the NIESR conference on 'Inward investment, technological change and growth: the impact of multinational corporations on the UK economy, 29th September, London 1999.

Cohen, W. M. and Levinthal, D. A. (1989) Innovation and learning: the two faces of R&D, *Economic Journal*, 99, pp. 569-96.

Conyon, M., Girma, S., Thompson, S and Wright, P. (1999) The impact of Foreign Acquisition on Wages and Productivity in the U.K, GLM Research Paper 99/8, School of Economics, University of Nottingham.

Djankov, S. and Hoekman, B. (2000) Foreign investment and productivity growth in Czech Enterprises, *The World Bank Economic Review*, 14 (1), pp. 49-64.

Driffield, N. L. (1999) Regional and industry level spillovers from FDI, presented at the NIESR Conference on inward investment, technological change and growth, British Academy, September 29th.

Dunning, J. H. (1977) Trade, location of economic activity and MNE: a search for an eclectic approach, in B. Ohlin, P.O. Hesselborn and P.M. Wijkman (Eds.) *The international allocation of economic activity*, London: Macmillan.

Dunning, J. H. (1993) *Multinational Enterprises and the Global Economy*, Addison-Wesley: Wokingham.

Feenstra, R. C. and Hanson, G. H. (1997) Foreign direct investment and relative wages: evidence from Mexico's maquiladoras, *Journal of International Economics*, 42, pp. 371-93.

Gillespie, G. P.G. McGregor, J. Kim Swales and Ya Ping Yin (1999) A regional computable general equilibrium analysis of the demand and 'efficiency-spillover' effects of foreign direct investment, paper presented at the NIESR conference on 'Inward investment, technological change and growth: the

impact of multinational corporations on the UK economy', 29th September, London 1999.

Girma, S., D. Greenaway and K. Wakelin (2000) Who benefits from foreign direct investment in the UK? Paper to be presented at the Royal Economic Society Conference, St. Andrews, July 2000.

Greenaway, D., R. Upward and P. Wright (2000) Sectoral mobility in UK labour markets, mimeo, University of Nottingham.

Haacker, Markus (1999) Spillovers from foreign investment through labour turnover: the supply of management skills, Centre for Economic Performance, London School of Economics.

Head, C. Keith, John C. Ries and Deborah L. Swenson (1999) Attracting foreign manufacturing: investment promotion and agglomeration, *Regional Science and Urban Economics*, 29, pp. 197-218.

Hymer, S.H. (1976) *The international operations of national firms: a study of direct foreign investment*, Boston: MIT press.

Jaffe, A, M. Trajtenberg and R. Henderson (1993) Geographic localisation of knowledge spillovers as evidenced by patent citations, *Quarterly Journal of Economics*, 108, pp. 577-98.

Kokko, A. (1994) Technology, market characteristics and spillovers, *Journal of Development Economics*, 43, pp. 279-93.

Lapan, H. and P. Bardhan (1973) Localised technical progress and the transfer of technology and economic development, *Journal of Economic Theory*, 6, pp. 585-95.

Sjöholm, Fredrik (1998) Productivity growth in Indonesia: the role of regional characteristics and direct foreign investment, Stockholm School of Economics, Working paper no. 216.

Taylor, Jim (1993) An analysis of the factors determining the geographical distribution of Japanese manufacturing investment in the UK, 1984-1991, *Urban Studies*, 30(7), pp. 1209-1224.

UNCTAD (1996) Incentives and foreign direct investment, UNCTAD, Division on transnational corporations and investment, Series A, No. 30.

UNCTAD (1997) *World Investment Report: Transnational corporations, market structure and competition policy*, New York: United Nations

Wang, J-Y. and Blomström, M (1992), 'Foreign investment and technological transfer: a simple model', *European Economic Review* , 36 , 137-155.

Wren, Colin and Jim Taylor (1999) Industrial restructuring and regional policy, *Oxford Economic Papers*, 51, pp. 487-516.

Young, Stephen, Neil Hood and Ewen Peters (1994) Multinational enterprises and regional economic development, *Regional Studies* 28(7), pp. 657-77.