

The importance of clusters for spillovers from foreign direct investment and technology sourcing

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This paper examines the link between cluster development and inward foreign direct investment. The conventional policy approach has been to assume that inward foreign direct investment (FDI) can stimulate significant clustering activity, thus generating significant spillovers. This paper, however, questions this and shows that, while clusters can generate significant productivity spillovers from FDI, this only occurs in pre-existing clusters. Further, the paper demonstrates that foreign-owned firms that enter clusters also appropriate spillovers when domestic firms undertake investment, raising the possibility that clusters are important locations for so called technology, or knowledge sourcing activities by MNEs.

Key words: Cluster, Foreign direct investment, Productivity spillovers
JEL classifications: F23, R12

1. Introduction

This paper tests for the importance of cluster effects in the determination of productivity spillovers from foreign direct investment (FDI). In so doing, it seeks to build on work that discusses the importance of productivity spillovers between the foreign and domestically owned sectors of the economy. Further, this develops work by Driffield and Love (2002) which discusses the importance of domestic investment or activity in explaining productivity growth in the foreign-owned sector. These issues are discussed within the context of the clustering of the domestic sector.

Recent work on regional development and regeneration suggests that one of the sources of competitiveness for localities is the presence of clusters or more generally of firm agglomerations (Porter, 2000; Cossentino *et al.*, 1996; Becattini *et al.*, 2003). Clusters have proved to combine a flexible organisation of production with high levels of specialisation and competence. This facilitates output quantity flexibility and

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variety, as required by a volatile demand. Moreover, the positive externalities generated by the closeness of many firms specialised in a particular sector, so tightly intertwined through production transactions and social relationships, has proved to trigger processes of innovation and learning.

The most common approach by policy-makers seeking to link localities to global markets has been to offer financial incentives to multinational enterprises (MNEs) in order to encourage the establishment of local production facilities. This policy of seeking to attract FDI by subsidy fits naturally with the dominant theoretical perspective on the determinants of FDI, which suggests that firms will use FDI as a method of entering foreign markets where they possess some knowledge-based 'ownership' advantage which cannot easily be exploited by some other route such as licensing. These policies are discussed at length in Armstrong and Taylor (1993) and Taylor and Wren (1997), for example, so it is not our intention to discuss these in detail here. However, while such policies are designed to generate direct and indirect employment increases, there is an expectation of a further gain as the social returns to inward investment exceed the private returns. Policy-makers are clearly alive to this possibility. In the UK, for example, regional development agencies have long encouraged MNEs to locate in their areas, in the explicit belief that local firms will benefit from spillover benefits.

There is also a relatively large literature seeking to link inward FDI to agglomeration (see, for example, Driffield and Munday, 2000; Cantwell, 1991, Head *et al.*, 1995), though there is little evidence that such inward investment forms a vital and sustainable cluster in the true sense. The asymmetric governance structure of this type of agglomeration is such that strategic decision-making powers lie solely with the MNE (typically a purchaser of local inputs), and little technology transfer between the foreign and domestic sectors is generated (De Propris, 2001).

While such investments may generate a geographical concentration of activities, they might not be 'clusters' in any real sense, but rather a few domestic firms providing low value added services to a large foreign subsidiary with high import intensity. In such cases, therefore, the potential for technology transfer between the sectors, or inward investment generating productivity growth in the domestic sector, is limited. As Morgan (1997) notes, the policy of subsidising inward investment was designed to address the symptoms of regional disparities, such as unemployment, rather than the underlying causes, such as low levels of technological development. It has been this short-termism that has prevented policy-makers from formulating a strategy for maximising the benefits of FDI and for long-term sustainable development.

This paper will, therefore, investigate the relationship between domestic firms and inward investors, from the perspective of technology flows and spillovers. In particular, we distinguish between domestic firms located within clusters from those outside clusters, on the basis of De Propris' (2004) cluster mapping exercise. Employing a standard augmented production function approach, we compare spillovers between foreign and domestic firms in the UK in cluster and non-cluster cases.

The paper proceeds as follows. Section 2 discusses MNEs' motives for FDI, focusing on the increasing importance of technology sourcing. Section 3 explores the literature on clusters and the link between FDI and cluster development. Section 4 discusses the measurement of productivity growth and externalities, and derives the econometric model, while Section 5 presents the data and the results of the

econometric analysis. Finally, Section 6 will provide some policy suggestions and concluding remarks.

2. Inward investment, spillovers and technology sourcing

The significance of spillovers from inward investment was demonstrated by Barrell and Pain (1997), who estimated that around 30% of the productivity growth in UK manufacturing between 1985 and 1995 could be attributed to the impact of inward investment. Further, for technology spillovers to be assimilated by domestic firms, the domestic sector must be sufficiently technologically advanced. While this is often a problem associated with developing countries, it is nevertheless still a problem in the UK (Driffield, 2001).

The theoretical basis for the importance of agglomeration, and particularly agglomeration based on the ability to attract FDI, is derived from theoretical models of industrial development (see, for example, Markusen and Venables, 1999). Agglomeration serves to increase the potential for technology transfer, and therefore improvements in technological capabilities. The presence of MNEs, as leaders in both technological and capital accumulation, will serve to stimulate further the possibility for agglomeration in such locations (Cantwell, 1991). Further, Head *et al.* (1995) report significant agglomeration that economies may be captured by both foreign and domestic firms, these being related to the proximity of similar facilities. This literature, however, fails to distinguish between types of agglomeration connected with inward investment. Further, while there is a growing literature (which will be discussed in Section 3 below) that seeks to link cluster formation to inward investment, this often ignores one key distinction. This relates to whether the inward investor has entered a pre-existing successful cluster, or the whether the observed concentration of activities is simply a collection of suppliers for the foreign firm.

In addition to the observed positive productivity effects from FDI, many studies, following Aitken and Harrison (1999) point to the possibility of negative as well as positive externality effects from external investment. Aitken and Harrison (1999) point out that MNEs entering a host economy may take market share from less efficient indigenous firms, forcing them to produce lower levels of output at higher average cost than was the case before entry. Where this effect is pronounced, it may offset any positive spillover effects derived from the MNEs, so that foreign entry has a net negative effect on domestic productivity. Clearly, competition may have a positive effect on domestic productivity in the long run, either by encouraging local firms to become more efficient or by forcing the least efficient out of business. Thus sectoral level productivity effects of inward FDI may well be negative in the short term, though positive in the long run. As yet, however, this remains unexplored econometrically.

While agglomeration increases the probability of technology transfer and spillovers from FDI, the literature on the theoretical motivation for FDI is increasingly turning to the possibility of 'technology sourcing', that is the desire of MNEs to access core competences in the host economy (see, for example, Cantwell, 1999). Kogut and Chang (1991) and Neven and Siotis (1996) point out that this possibility has exercised the minds of policy-makers in the US and the EU, with concerns that host economies' technological base may be undermined by such technology sourcing FDIs. Siotis (1999), for example, shows that the presence of such spillovers may induce firms to

invest abroad even where exporting costs are zero. The purpose of this paper is to test for the importance of clusters in the determination of spillovers from FDI both to and from the host economy.

While the importance of the clustering of activity is often ignored in the literature that seeks to quantify the importance of spillovers from FDI, if not in the theoretical literature, this paper offers a further extension, linking the importance of clusters to the literature of technology sourcing FDI. The empirical work seeking to examine the incidence of technology sourcing has several strands. Cantwell and Iammarino (2000), for example, examine the geographical concentration of MNEs' activities in certain regions. This, in turn, is linked to the existence of localised industries and technology-seeking opportunities. The attention of MNEs to the local knowledge capacity of the host economy as a location factor has been studied for Japanese, Swedish and German MNEs and for foreign investment in the US (for a survey, see Frost, 2001). Almeida (1996) finds that foreign investment in Silicon Valley as a knowledge-intensive region, was driven by 'knowledge sourcing', in other words by the interest in tapping into the local technology and accessing local knowledge networks.

There are numerous tests of technology sourcing, such as the mapping of innovatory capacity across locations (Cantwell and Iammarino, 2000) or relating FDI flows to R&D intensity differences (Neven and Siotis, 1996). There is, however, a growing literature concerned not with testing for spillovers from FDI, but for so called 'reverse' spillovers as an indication of technology sourcing. This concerns the identification of productivity externalities generated by domestic firms, and assimilated by the subsidiaries of foreign MNEs, following Driffield and Love (2003). Our work, therefore, is based on the search for spillovers within a production function framework. This literature is discussed in some detail below, while Görg and Greenway (2002) present a detailed survey of the literature. This paper then seeks to extend this literature by specifically analysing the importance of clusters, not only in terms of spillovers from FDI, but also for 'reverse' spillovers, that is technology or knowledge flowing from the domestic to foreign sectors. As yet, there seems to have been little theoretical or empirical work on the link between FDI and firm clusters at the industry level.

3. Definition and identification of clusters

We define clusters as being geographical agglomerations of small to medium-sized firms specialised in one or a few related sectors. Definitions of clusters have become increasingly fragmented as alternative classifications have emerged. As a result, it is now argued that the concept of cluster has increasingly become a 'chaotic concept' too fuzzy to be pinned down (Martin and Sunley, 2003). Markusen (1996), Gordon and McCann (2000), Simmie and Sennett (1999) and Belussi and Arcangeli (1998) have all suggested possible typologies, which are all based on an in-depth analysis of clusters on a case-by-case basis. Martin and Sunley (2003) argue that cluster definitions tend to stress geographical proximity, technological proximity, production complementarities, external economy and intangible assets such as social capital. As a result, classifications tend to become narrower and more case-specific, reliant on qualitative measurement. We therefore consider a broader definition of cluster that covers three main characteristics associated with clusters: geographical proximity, industry

specialisation and the presence of small to medium-sized firms. This definition is compatible with the quantitative econometric analysis developed therein. Such clusters contain production and social networks that can generate external economies, knowledge spillovers and innovation, as case studies often conclude (Feldman, 2001; Kenney and von Burg, 1999).

Cluster firms are characterised by a high degree of specialisation and complementarity. This generates dynamic processes of knowledge creation (learning and innovation) and knowledge transfer (diffusion and synergies). In clusters, there are collective learning processes that generate innovation and thereby competitiveness also in non-high-tech intensive sectors. As a result, clusters can be extremely competitive in what the literature defines as traditional sectors; for instance, Sassuolo (Italy) ceramic tile industrial district accounts for one-third of the sector world export (Menghinello, 2003). An innovative and competitive cluster can produce positive externalities to its entire region: as the cluster grows, the extent of vertical and horizontal product differentiation increases. As a result, the cluster becomes a centre of accumulated competences across a range of related industries, and across various stages of production (the so-called production *filière*). These localised centres of accumulated knowledge can be very attractive to outside firms, and thus attractive to inward investors contemplating a location decision.

An extensive academic literature on clusters has developed a series of necessary and sufficient conditions for the formation of competitive clusters. Studies on industrial districts in Italy (Becattini, 1987, 1990; Becattini *et al.*, 2003; Cossentino *et al.*, 1996; Leonardi and Nanetti, 1994), clusters in Portugal (Porter, 1998), in the US (Porter, 2000; Feldman, 2001; Kenney and von Burg, 1999) and in Norway (Ashheim and Isaksen, 1997), innovative *milieux* in France (Longhi, 1999) and in developing countries (Rabellotti, 1997; Guerrieri *et al.*, 2001) have strengthened the argument that agglomerations of small and medium-sized firms can catalyse regional industrial competitiveness. The sources of localities' competitive advantages are industrial specialisation, the external division of labour, agglomeration and external economies, embedded competences and a balance between competition and cooperation, so called 'co-opetition' (Nalebuff, 1996). Such competitive advantages are fed through a spontaneous process of knowledge and competence accumulation. This is embedded in the local network of production and innovation that can characterise a cluster, and contributes to the generation of positive externalities.

3.1 Clusters and FDI

Cluster policy has almost become synonymous with regional policy. For instance, almost all Regional Development Agencies in England specifically target clusters for the delivery of their regional strategies. Equally, national and regional policy-makers have often stressed the role of foreign investment to support the industrial development or regeneration of less-favoured regions. Foreign investment is often expected to alleviate structural unemployment, to create or revitalise local industries and, more importantly, to generate positive externalities through both type 1 and type 2 multipliers. Although in aggregate terms it has been shown that FDI in the UK has generated productivity growth for the host economy (Driffield and Love, 2002), it has also become clearer that the link between regional competitiveness and FDI-generated clusters is extremely uncertain.

Further, studies have also shown that large inward investments can attract and promote the development of agglomerations of small firms, that act as suppliers to the foreign subsidiary. This, perhaps erroneously, is often linked to the clusters literature when stressing the importance of attracting inward investment in the development of a region's social and physical infrastructure (Peck, 1996; Morgan, 1997). The possibility that FDI can act as a channel to promote new cluster formation has become increasingly explicit. However, FDI-generated clusters have often proven to be fragile and short-term: the MNE does not embed itself in the locality but simply relocates if economic conditions change; there is no or little technology transfer and, finally, if there are spin-offs from the MNE, these tend to be sub-contractors for whom the MNE is the only buyer. The outcome is a monopsonistic cluster (De Propris, 2001; Markusen, 1996), whose survival depends on the MNE. A necessary condition for the long-term positive impact of inward investment is the existence of location-specific factors that encourage the MNE to commit itself to a particular locality. These include local tacit or uncodified knowledge and information that cannot be disseminated outside the cluster and which constitute clusters' intangible assets. As the latter are immobile and embedded, they can then be a key factor in the attraction of FDI. Location-specific intangible and immobile factors prevent the easy replacement of such localities, and reduce the propensity of MNEs to be 'footloose'.

4. Measurement of productivity externalities from FDI

The social returns to inward investment have been of interest to both policy-makers and academics for some time. Indeed, a good deal of work has been carried out on the scale and scope of spillovers from FDI (for a summary, see Görg and Greenaway, 2002). In summation, there is evidence that technology spillovers do occur, but they are limited geographically and are dependent on the actions of the firms concerned. More recently, interest has focused on so called 'reverse' spillovers, that is, productivity gains that accrue to foreign firms as a result of knowledge creation in the domestic sector (Driffield and Love 2003). The importance of the spatial organisation of domestic industry in explaining the actions of MNEs, or the size of spillovers, is largely ignored, beyond simple distance effects (Head *et al.*, 1995; Driffield and Munday, 2000). This paper will therefore address this, by linking the concept of clusters to that of technology or knowledge transfer between foreign and domestic firms.

There is a relatively large literature, following Caballero and Lyons (1989, 1990, 1992), which essentially seeks to encompass the industry-level spillovers that occur as a result of an increase in external output expansion. Following Griliches (1992), the standard model of productivity growth describes the process in terms of an augmented production function (see, for example, Griliches and Lichtenberg, 1984; Haddad and Harrison, 1993; Verspagen, 1996; Coe and Helpman, 1995). This methodology is further summarised in Griliches (1995).

The use of panel data in estimating productivity growth is now well understood, based on the initial work of Mankiw *et al.* (1992), or in the context of industrial economics studies of externalities, of Caballero and Lyons (1989, 1990, 1992). Further, Islam (1992) shows that a dynamic specification is appropriate, as growth is in part dependent on past performance, and past input levels.

Thus, the basic equation to be estimated is given as

$$\ln Q_{irt} = a + \gamma \ln Q_{irt-1} + \beta_1 \ln(K_{irt}) + \beta_2 \ln(L_{irt}) + \mu t + \sum_{k=3}^5 \beta_k X_{irt-1} + v_{irt} \quad (1)$$

The ‘internal’ variables are straightforward: Q is output flows, measured as value added; K is the flow of capital services, proxied by the capital stock; and L is flow of labour services, proxied by the number FTE employees. X is the vector of externalities outlined above, and t is a time trend, as a proxy for exogenous technological change. The data have an industry (i) and regional (r) component as well as a time component.

Assuming time-specific and observation-specific effects

$$v_{irt} = \alpha_{ir} + \mu_t + u_{irt} \quad (2)$$

The estimation problems of dynamic models from short panels are well documented in the econometric literature (see Baltagi, 1995, and references therein). The basic difficulty lies in the fact that, in the presence of fixed effects, the lagged dependent variable is correlated with the disturbance term. Standard ‘within’ transformation typically used in static models fails to deliver consistent estimators. A popular way of circumventing this problem is to remove the fixed effects via first-differencing and then employ a variant of the instrumental variable estimation technique (e.g., GMM). In this paper, lagged employment, capital and output are employed as instruments in the first-differenced (i.e., productivity growth) equations in the spirit of Anderson and Hsiao (1982) and Arellano and Bond (1988, 1991).¹

$$\begin{aligned} \Delta \ln Q_{irt} = & \gamma \Delta \ln Q_{irt-1} + \beta_1 \Delta \ln(K_{irt}) + \beta_2 \Delta \ln(NL_{irt}) \\ & + \beta_3 \Delta \ln(ML_{irt}) + \sum_{k=3}^5 \beta_k X_{irt-1} + e_{irt} \dots \end{aligned} \quad (3)$$

Equation (3) represents a dynamic panel data model of total factor productivity.

With the potential for two-way spillovers, the estimation of (5) for individual groups should allow for simultaneity in investment and spillovers, both from foreign to domestic firms, and in reverse. Equally, it is important to distinguish between effects inside and outside clusters. Equation (3) is, therefore, estimated for the foreign and domestic sectors simultaneously for cluster and non-cluster sub-samples, respectively. This is done by employing an iterated three-stage least squares (FD-3SLS) using the same set of instruments as described above (that is, the instrument set suggested by single equation dynamic panel data procedures). For the foreign-owned sector, the variables Q , K and L are defined as above, but for the foreign-owned sector only. Thus, when determining the effects of domestic investment on the foreign sector, we employ the measure of domestic capital formation as the source of the externality to investigate whether domestic firms generate technological externalities that are appropriated by foreign-owned firms in the locality.

Over-identification test statistics (which are the FD-3SLS objective function evaluated at the solution points and divided by the sample size) are also computed to test the validity of the instrumental variable candidates. Econometrically, the

¹ Our approach of estimating the system of dynamic panel equations is in the spirit of Holtz-Eakin *et al.* (1988), using lagged values as instruments to generate orthogonality conditions on differenced data, and employing GMM.

use of lagged external investment results in a tightly defined source of potential domestic-to-foreign spillovers, so it is unlikely that the ‘spillover’ variable will be related to the error term in (2).¹

5. Data

The econometric analysis draws on two sets of data: the identification of clusters in the UK is based on employment by firm size and by travel-to-work-area (TTWA). The data used to measure the spillover effects are stratified by industry and region for input and output flows for the foreign-owned and domestic sectors of the UK.

The methodology employed here to map clusters is well known, having been developed in the mapping of local production systems (LPS) in Italy (see, for example, Brusco and Paba, 1997).² The methodology relies on four criteria: (a) share of employment in the manufacturing sector; (b) size of firms; (c) industrial specialisation; (d) industrial specialisation and size of firms. It relies on data on employment shares in firms (considered as units of production) according to size, sector and location. Small firms have less than 100 employees, small to medium-sized firms (SMEs) have less than 250 employees, and large firms have more than 250.³ Manufacturing sectors are defined according to national classifications; for the UK, we consider the two-digit classification supplied by the Office for National Statistics so that the findings of the cluster mapping exercise are compatible with the economic indicators database. Drawing on Sforzi (1990), the most appropriate geographical units to identify clusters are those that overlap with local labour markets: the UK Office for National Statistics provides data broken down by 297 TTWAs for England, Wales and Scotland. TTWAs are self-contained local labour basins and reflect the overlapping of the community of people living in a certain area and the population of economic activities, which is a very important feature of clusters.⁴

The four criteria were applied to the 297 TTWA for the UK, and identified their three most important industries, and degree of specialisation. The TTWA were then classified by three criteria: manufacturing intensity (manufacturing or non-manufacturing clusters), firm size (clusters of small and medium-sized firms or clusters of large firms) and sector specialisation.⁵ This then suggested that 190 TTWAs are characterised by the presence of manufacturing/non-manufacturing clusters of small and medium-sized firms. The sectoral specialisation is then determined by the sector in which they have the highest location quotient.⁶

¹ See Oulton (1996) for a full discussion of this. Empirically, this can be tested for using standard heteroscedasticity or specification tests.

² For an extensive discussion about this methodology and its implications, see Sforzi (1989, 1990). The main contributions in Italian industrial districts include: on Tuscany, see Leonardi and Nanetti (1994), on Emilia Romagna, see Brusco (1982) and Lazerson (1990), on the footwear district in Marche and Veneto, see Rabellotti (1997).

³ It must be noted that the European Union considers small firms as having fewer than 50 employees and SMEs as having fewer than 250.

⁴ For a detailed description of the methodology for mapping LPS (De Propris, 2004).

⁵ It has to be noted that five of the 297 TTWA did not satisfy the four criteria, namely, they did not present any form of cluster.

⁶ The main finding of the mapping exercise was to identify eight types of LPS in the UK: districts, non-specialised districts, non-manufacturing/specialised LPS of SMEs, non-manufacturing/non-specialised LPS of SMEs, manufacturing/specialised LPS of large firms, manufacturing/non-specialised LPS of LF, non-manufacturing/specialised LPS of LF and non-manufacturing/non-specialised LPS of LF (De Propris, 2004).

Investment or output data are not available at the sectoral level disaggregated by TTWA, such data are only available at the regional level. Given this data constraint, in order to measure the spillover effects given by FDI, we identify individual region/industry observations that contained significant clusters, and split the data into ‘cluster’ and ‘non-cluster’ observations accordingly.

5.1 Data employed in the econometric study

The data were gathered from the Annual Production Inquiry (formerly the Census of Production), and directly from the UK Office of National Statistics, who provided the data on the foreign-owned sector alone, to allow the calculation of the domestically owned sector. The data are industry and regional level data for the UK, covering 1993–1998. There are 11 standard planning regions,¹ and 23 manufacturing sectors (2-digit level), giving 253 observations per year. The advantage of such data is that they allow the evaluation of inter- and intra-regional effects, as well as inter- and intra-industry effects. The measures of inward investment that are then used as potential sources of externalities are foreign investment at the regional level, at the industry level and jointly at the industry and regional level.

Q represents domestic industry output, measured using gross value added in the industry and region at time t . K is the capital stock of the domestic industry, the change in this is given by net capital investment, in the UK-owned sector. This is expressed in £millions. Data on the capital stock are not available at this level of aggregation, so the sum of net investment over the previous three years is used as a proxy. A standard depreciation rate of 10% is used. L is employment domestic owned industry.

Crucially, the measure of foreign investment employed in Table 1 is new capital expenditure in foreign-owned or controlled firms. As such, this therefore does not

Table 1. Measures of ‘external investment’^a

<i>Foreign to domestic spillover effects</i>	
FDI_{irt-1}	The stock of foreign capital in the relevant industry and region for the previous year.
FDI_{it-1}	The stock of foreign capital in the relevant industry across all regions for the previous year.
FDI_{rt-1}	The stock of foreign capital in the relevant region across all industries for the previous year.
<i>Domestic-to-foreign spillover effects</i>	
DI_{irt-1}	The stock of domestic capital in the relevant industry and region for the previous year.
DI_{it-1}	The stock of domestic capital in the relevant industry across all regions for the previous year.
DI_{rt-1}	The stock of domestic capital in the relevant region across all industries for the previous year.

^a These are all included in log form in the econometrics.

¹ There was a change in regional classifications in 1995 for the UK, increasing to 14 regions. In order to maintain consistency in the data, these are condensed to 11.

include flows of capital that are simply acquisitions of UK firms by foreign firms. All monetary data are in real terms at 1993 prices.

6. Results

Equation (3) was then estimated for four separate subsets of the data. We first distinguish between clusters and non-clusters, and also between the foreign and domestic sectors. We therefore estimate two pairs of simultaneous equations, the foreign and domestic sectors within clusters, and the foreign and domestic sectors outside clusters. The results for the estimation on the four sub-samples are given in Tables 2 and 3. The usual tests for model performance, specification and identification are performed, and suggest that the specification and econometric approach are appropriate. Further explanations of these tests are provided in the footnotes to Table 2.

For both the foreign and domestic sectors, the internal variables (capital and labour, as well as the lagged dependent variable) behave much as expected, while the time trend is much larger for the clusters group. This suggests that total factor productivity growth is greater in clusters than in non-clusters. Equally, the lagged dependent variable has greater significance for the cluster sample, the difference being more marked for the foreign sector. This suggests that experience effects are more important for MNEs that enter clusters than for those that do not.

Table 2. *Spillovers from FDI*

	Clusters	No clusters
Parameter	Estimate (<i>t</i> value)	Estimate (<i>t</i> value)
Time trend	0.948104 (3.16)**	0.233194 (1.18)
Q_{irt-1}	0.023903 (5.22)**	0.025779 (2.70)**
L_{irt}	0.65600 (5.90)**	0.68069 (6.42)**
K_{irt}	0.24446 (3.54)**	0.262203 (2.90)**
FDI_{irt-1}	0.060982 (4.46)**	-0.045815 (-1.77)*
FDI_{it-1}	-0.092373 (-5.05)**	-0.121932 (-4.53)**
FDI_{rt-1}	0.096663 (3.65)**	-0.034283 (-1.66)
Spatial autocorrelation (Morans I) ^a	0.841	1.605 (0.108)
Time dummies	Yes	Yes
Specification $\sim\chi^2(6)$ (<i>p</i> value) ^b	6.129 (0.408)	4.88 (0.559)
Sargan (validity of instruments) <i>p</i> value	0.321	0.221
Inclusion of further lags of FDI variables LR test $\sim\chi^2(4)$	3.648 (0.455)	3.897 (0.408)
Industry autocorrelation (Morans I)	1.455 (0.148)	1.054 (0.292)
Serial correlation AR(2) $\sim\chi^2(1)$ ^c	0.687 (0.408)	0.896 (0.347)
N	284	732

^a Irrespective of the chosen specification between (3) and (4), there are further considerations with this estimation. Spatial autocorrelation generates potential bias in the results when: $E(u_i u_j) \neq 0$. The most efficient test for spatial autocorrelation, following Anselin and Rey (1991) is based on Moran's I statistic (Moran, 1950). There was no evidence of any spatial autocorrelation in the errors. Equally, there is no evidence of inter-industry autocorrelation or serial correlation in the errors.

^b This is based on testing the Cobb–Douglas specification against a translog specification.

^c This LM test is outlined on Baltagi (1995, p. 93).

**significant at 1%.

*significant at 5%.

Table 3. Spillovers from domestic to foreign firms (reverse spillover)

	Clusters	No clusters
Parameter	Estimate (t-value)	Estimate (t-value)
Time trend	0.047537 (1.36)	1.32901 (0.77)
Q_{irt-1}	0.264966 (7.39)**	-0.000131 (-0.02)
L_{irt}	0.68824 (4.23)**	0.718035 (8.44)**
K_{irt}	0.226050 (7.76)**	0.1935216 (2.08)**
DI_{irt-1}	0.095150 (2.95)**	0.0052364 (0.177)
DI_{it-1}	0.031327 (2.63)**	-0.075793 (-2.00)**
DI_{rt-1}	0.053710 (1.04)	-0.029819 (-1.94)*
Spatial autocorrelation (Morans I)	0.540 (0.589)	0.762 (0.446)
Time dummies	Yes	Yes
Specification $\sim \chi^2(6)$ (<i>p</i> value)	8.880 (0.185)	8.400 (0.212)
Sargan (validity of instruments)- <i>p</i> value	0.278	0.214
Inclusion of further lags of DI variables LR test $\sim \chi^2(4)$	4.813 (0.31)	4.089 (0.349)
Industry autocorrelation (Morans I)	1.452 (0.145)	0.603 (0.546)
Serial correlation AR(2) $\sim \chi^2(1)$	0.457 (0.499)	1.099 (0.249)
N	284	732

**significant at 1%.

*significant at 5%.

The marked difference between the cluster and non-cluster groups becomes apparent when one considers the externality effects. For the domestic sector, the coefficients on the FDI terms demonstrate spillover effects that flow from foreign to domestic firms. These effects, however, are limited to those industry/region combinations that possess significant clusters. Firms in clusters gain significantly from local FDI, both within the industry of the domestic firm, and across other industries in the region. In the non-cluster case, however, there are no such spillovers, merely the negative ‘crowding out’ effect discussed above. Firms in clusters still suffer from the increased competition that new foreign investment generates, but any loss in productivity is more than offset by the beneficial effects of FDI. Thus, one can draw a clear distinction in terms of the impacts on domestic total factor productivity growth from inward investment, in terms of the differential effects in clusters and non-clusters. Domestic firms in clusters gain significantly from inward investment, while firms outside clusters do not. This perhaps also demonstrates why there has been so much variation in spillovers results reported elsewhere (see, for example, the discussion in Görg and Strobl, 2001).

Turning now to ascertain whether foreign firms assimilate spillovers from domestic firms’ investment, one can see that the pattern is very similar to that for the domestic firms. As is commonly reported elsewhere, there is very little exogenous total factor productivity growth in foreign affiliates. This is generally explained in terms of new technology being inherent in inward investment capital (possibly related to R&D elsewhere in the MNE rather than generated exogenously). Similarly, past performance affects total factor productivity only in foreign affiliates that are part of clusters, with labour inputs contributing to over 70% of value added in non-cluster firms.

These results demonstrate clearly that investment by domestic firms in clusters generates total factor productivity growth in inward investors within clusters. While one cannot necessarily infer the motivation for foreign firms to enter clusters from these results, there is clear evidence of technology sourcing (intended or otherwise) by foreign affiliates located in clusters in the UK. Investment by UK firms at the local industry level, and across the UK at the industry level, generates total factor productivity growth for foreign firms, but only where the MNEs are located in or near clusters. This suggests that clusters are attractive locations for MNEs, and that technology generated within clusters is transferred to MNEs. The same, however, cannot be said of foreign firms outside clusters. Indeed, the results for the domestic and foreign-owned sectors of the economy are remarkably similar. They suggest that the key distinction for investment to generate productivity externalities is not between foreign and domestic firms, but between clusters and non-clusters. As well as having significant policy implications, this may also be a potential solution to why results regarding productivity growth from inward investment are so varied.

7. Policy implications and concluding remarks

This paper explores the link between FDI and clusters, in particular the spillover effects between the foreign and domestic sectors, within and outside clusters. Within the host economy, it distinguishes between localities with clustered industries and localities without clustered industries.

The findings of the econometric analysis suggest that firms in clusters gain significantly from FDI in their region, both within the industry of the domestic firm and across other industries in the region. In the non-cluster case, however, there are no such spillovers, merely the crowding out effect at the industry level, discussed above. Firms in clusters suffer from the increased competition that new foreign investment generates, but any loss in productivity is more than offset by the beneficial effects of FDI. Overall, domestic firms in clusters gain significantly from inward investment, while firms outside clusters do not.

This suggests that both the private and social returns to FDI are greater when MNEs enter a pre-existing cluster, suggesting that both technology sourcing and foreign-to-domestic spillovers are present in such cases. This prompts a rethink of the aims and objectives of both cluster policy and FDI policy for the UK regions. FDI-generated clusters can be fragile and have often proved unable to provide a sustainable development for localities. One possible explanation for this is that foreign-owned firms are more footloose than indigenous firms. As such, they are more likely to react to adverse economic conditions by restructuring, relocating, selling or closing plants down. Well-known examples of this can be found in, for example, Görg and Strobl (2003), Bailey (2003) or Pyke and Tomaney (1999). This would seem to suggest that a region's over-reliance on international capital for its development and competitiveness may be unwise.

Our findings do, however, suggest that there is scope to reconsider the role of FDI for regional development, especially in the presence of clusters. FDI into a cluster generates gains for the host economy and, in turn, interaction with the domestic sector generates productivity growth for the MNE. This, in turn, suggests that inward FDI into clusters not only maximises the benefits for the host economy, but also provides

the greatest potential for technology sourcing on the part of the multinational. This situation, however, should not be confused with attempts by regional policy-makers to foster cluster development through inward investment, as has been often the case in UK regions. Rather, cluster policy should be focused on the support of local and embedded competences within domestic firms, whether through encouraging greater cooperation between firms or the development of new SMEs. As centres of accumulated knowledge, these will then become attractive localities for MNEs, in that the latter would be attracted, not by mobile production inputs (e.g., cheap labour, incentives) but by location-specific production inputs. In other words, cluster policy has to set the scene for a strategic and selective process of targeting and attracting FDI.

The results presented in this paper suggest that inward investment in the UK does act to increase productivity in the domestic sector. However, these effects are limited to firms that are located in pre-existing clusters. The theory of FDI suggests that these effects are due to superior foreign technology being transferred to domestic firms, though only to those in a position to assimilate the new technology. Within this context, cluster firms are ideally placed to gain from such effects, as they are receptive to external knowledge and information. While it is easy to think in terms of technology, such effects may, however, be broader than this. They may encompass superior management techniques and so-called 'vertical' spillovers as technology or the beneficial effects of new technology are transferred up and down the value chain. These results, albeit over a relatively short time frame, suggest that inward investment in itself will not stimulate such cluster effects, but that foreign firms entering pre-existing clusters will generate significant productivity growth for both parties.

Regional policy analysis (in the UK at least) has tended to focus on the justification for encouraging multinational firms to locate in peripheral areas or regions with high unemployment and low productivity. This analysis is based on the importance of the direct and indirect employment effects of inward investment. This paper, however, suggests that the nature of production spillovers and the beneficial effects for the UK economy would be greater if inward investment were attracted to existing centres of activity. This is likely to be the strongest channel for positive production spillovers to the domestic sector and thus make the greatest contribution to productivity growth. The precise nature of the desired interactions between domestic and foreign firms in such locations has, however, been little explored, and we suggest more work is required in this area. Further, the results presented here suggest that, from a regional policy perspective, cluster formation is more important than attracting inward investment in stimulating productivity growth. The relative magnitudes of their contributions to local development, however, require further investigation.

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