SERC DISCUSSION PAPER 16

Spillover and Backward Linkage Effects of FDI: Empirical Evidence for the UK

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March 2009

This work was part of the research programme of the independent UK Spatial Economics Research Centre funded by the Economic and Social Research Council (ESRC), Department for Business, Enterprise and Regulatory Reform (BERR), the Department for Communities and Local Government (CLG), and the Welsh Assembly Government. The support of the funders is acknowledged. The views expressed are those of the authors and do not represent the views of the funders.

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Acknowledgements
An earlier version of this paper was presented to the 2008 European Regional Science Association Congress, Liverpool, 25th-28th August 2008.

Abstract
Recent work (including that of the author) on the impact of FDI has been based on micro-level (i.e. firms, establishments or plants) data, since this allows much greater control when examining such issues as whether FDI plants are more productive or innovative; whether there are spillovers to indigenous plants from FDI; and whether foreign-owned plants can facilitate the building-up of clusters. The traditional approach (which is still prevalent in the literature) considers whether those industries and/or regions with the greatest concentrations of FDI experience higher productivity, growth, spillovers, clustering affects, but such analysis does not tackle the issue of cause-and-effect and therefore amounts to little more than observing correlations between the growth of FDI in an industry/region and the overall growth of the industry/region. If FDI plants are attracted to co-locate with better performing industries and/or 'regions' (to benefit from potential spillovers themselves), then this does not amount to FDI necessarily being the source of greater economic benefits. Thus the purpose of this review paper is to report on the empirical evidence for the UK (recent and historical) specifically related to: (i) FDI plants – are they 'better' (i.e. have higher productivity, or more innovative, etc)? And predicated on whether FDI is better: (ii) are there spillovers from FDI? Lastly, (iii) are clusters established around FDI plants? The limitations of this evidence-base are discussed and, together with the results reported in the literature, resulting in some key research questions that need to be addressed in future empirical work, especially at the spatial level in the UK.

Keywords: Multinational firms, FDI, spillovers
JEL classifications: F2, L1

1. Introduction

This paper is an overview of the literature on how Multinational Enterprises (MNE's) impact on productivity in the UK. The emphasis is on inward foreign direct investment (FDI), but mention is also made of the impact of outward FDI on UK productivity. Generic issues that are covered include the data that are used to measure productivity and productivity impacts, and therefore how these are measured (including the techniques used). Generally in the UK most micro-level panel data comes either from returns submitted to Companies House (as required by tax rules), and then made available by commercial organizations (e.g. the FAME database, or OneSource), or from the data collected by the Office for National Statistics as part of the Annual Business Inquiry (and made available in the ONS Virtual Microdata Laboratory through the Annual Respondents Database – or ARD).[1] These data sources differ both in coverage and in terms of how nationally representative they are, and this has implications when econometric methods are used to test hypotheses (such as whether there are productivity spillovers from FDI). For example, the FAME data is heavily biased towards larger companies and is therefore not representative of smaller- and medium-sized companies operating in the UK (see Harris and Li, 2007, especially Table 2.11, for evidence).

There are also data problems when constructing proxy measures of FDI presence leading to spillovers – mostly aggregate estimates of FDI presence in an industry or region are used as proxies and this raises issues of whether this is adequate for measuring actual linkages between such FDI 'presence' and TFP in the domestic firms or plants being considered (put another way, we almost never have data on whether there are actual flows of knowledge, people, goods, or information between the micro-units in the data). Thus there is a generic issue of whether causality goes from FDI firms/plants affecting productivity in domestic firms, and/or whether there are causal flows in the opposite direction as well; often the econometric methods used amount to establishing at best a correlation between FDI presence and productivity which may be biased (usually upwards if causality goes in both directions).

The last data issue mentioned at this stage is the appropriateness of using micro-level panel data or more aggregated (industry-level) data when seeking to measure the linkage effects of FDI in the host economy. Most early studies used aggregated data (and indeed some still do) because of its availability, although it would seem fairly obvious that data at the firm or plant level is preferable as then it is possible to measure more exactly the impact of FDI on domestic productivity; with industry-level data it is usually not possible to separate out the domestic and FDI sub-groups unless all the variables needed are sub-divided by country of ownership. It is also likely that there are individual firm level characteristics that are important in terms of whether any spillovers can be internalized by the domestic firm; e.g., the level of absorptive capacity of each firm is likely to be important in determining the size of any FDI productivity impacts. Such heterogeneity is important, and can be utilized to provide more in-depth analyses, but it comes at a cost; in particular, there is a need to use panel data techniques that can also take account of heterogeneity linked to

[1] ONS data, derived from the ABI (and its predecessors) is also the most common source for more aggregated industry-level data that tended to be used before the more wide-scale availability of micro-datasets.

unobservable differences in firm performance (i.e. we need to account for 'fixed effects'). Such panel data techniques also need to contend with other important econometric issues such as endogeneity and spatial autocorrelation.

Turning to the techniques used to measure total factor productivity (TFP), there are important issues raised when TFP is derived firstly using, say, a production function and then these estimates comprise the dependent variable in a second stage model that seeks to explain the determinants of TFP. This leads to biased and inefficient parameter estimates for use when testing hypotheses.

All of the above issues are generally common to whatever research questions are being considered on how and when FDI impacts on productivity in the UK. In this paper, we start with the specific question of whether the subsidiaries of MNE's are 'better' (here in the terms of having higher productivity). If this is not the case, it is difficult to see why there should be significant pecuniary or non-pecuniary spillovers to domestic firms. Indeed when inward FDI is technology sourcing (rather than exploiting – see Love, 2003; Driffield and Love, 2007) it is as likely that spillovers benefit the MNE subsidiary rather than domestic firms. Section 3 then considers the question of whether there are direct productivity benefits from FDI in terms of a 'batting average' effect (i.e. if they are better their greater presence should, by definition, increase overall productivity and productivity growth); whether plants acquired by MNE's improve productivity post-acquisition (or do MNE's mostly 'cherry-pick' from the best domestic plants?); and whether outward FDI improves the domestic productivity of UK MNE's (with possible further productivity effects spilling over to other non-MNE domestic plants). Section 4 looks at the most prolific literature in this area, i.e., whether there are indirect benefits from FDI through spillover effects. Here we cover a number of issues including the definition of potential spillovers (including intra-industry, inter-industry, and agglomeration spillovers); the importance of different types of FDI (linked to why MNE's locate in the UK and thus technology sourcing versus exploitation, as well as export orientation); the importance of domestic firms being able to absorb any spillovers; and the size of spillovers for the UK as reported in the literature. The question of whether FDI plants 'cluster' and whether this produces further spillovers (and indeed the extent to which spillovers are localised) is taken up in more detail in section 5. Section 6 briefly covers the importance of trade (exporting and especially importing) as a source of spillovers, in order to try to put into perspective the relative importance of FDI in boosting TFP in the UK. Finally, there is a summary and conclusions, with the latter concentrating on the policy implications that come from this literature (e.g., is the cost of government assistance to FDI justified in terms of the pecuniary benefits to UK productivity from greater inward investment, especially in relation to FDI attracted to the assisted areas of Britain; and should so much effort be spent on targeting footloose MNE's to come to the UK, or would it be more effective to boost domestic firms absorptive capacity so they can benefit from any spillovers).

2. Are FDI Plants Better?

It is perhaps surprising that there have been few studies using micro-based data to consider whether FDI plants operating in the UK are 'better' than domestic plants. Griffith (1999) was the first such study using data from the ARD, and she produces

estimates of the Cobb-Douglas production function that show that foreign owned establishments in the motor vehicle industry do not have significantly higher levels of productivity, after taking account of different levels of factor inputs. However, Griffith did not weight the data to take account of the fact that the information collected by the ONS are biased towards larger establishments; weighting the ARD data, Harris (2002) found that foreign-owned plants are significantly more productive than UK-owned plants (US and EU-owned plants were some 21-26% more productive), when using the same econometric approach as that adopted by Griffith. The latter was only able to show that larger establishments in the industry have comparable productivity (having taken account of different input mixes). As pointed out by Harris (op. cit.), if larger UK- and foreign-owned establishments both have many of the characteristics associated with higher productivity (and this is captured by ownership dummy variables used to proxy for such characteristics), then perhaps it should not be a surprise that Griffith found no statistically significant difference using the unweighted sample. If productivity differences are greater when including the smaller (and mainly independent, single establishment) units, then unweighted data masks the differences between the foreign- and UK-owned sectors; i.e., there is a problem of a sample selection that arises from endogenous stratification (see the appendix in Harris, op. cit., for further details).

A more extensive study for UK manufacturing using plant-level data from the ARD for 1974-1995 and 20 4-digit manufacturing industries was undertaken by Harris and Robinson (2003).[2] Looking at the arguments put forward as to why foreign-owned plants should be better, their review of the literature pointed to early work by Hymer (1976), and more recent contributions of Aitken and Harrison (1999) and Pfafferymayr and Bellak (2002), that suggested foreign firms should possess some firm-specific advantage that gives them an absolute cost advantage over domestic plants such as: specialised knowledge about production; superior management and marketing capabilities; export contacts; and co-ordinated quality-oriented relationships with suppliers and customers. Thus they locate subsidiaries overseas in order to exploit such advantages. Furthermore, FDI may also reduce the productivity of domestically owned plants, particularly in the short run through increased competition, in imperfectly competitive markets with increasing returns to scale, raising the average costs of domestic competitors if they lose market share, thus reducing their productivity levels.

However, Harris and Robinson (op. cit.) also list some counter arguments as to why foreign affiliates may not be as productive as domestic plants, particularly in the short-run: foreign-owned plants may have lower efficiency levels if there are initial difficulties in assimilating new plants into the FDI network (Dunning, 1988, 1998). This may also be linked to cultural differences in the host market and indeed Caves (1996) argues that when a MNE founds or acquires subsidiaries abroad it incurs a fixed cost of learning how things are done in that country. In addition, foreign firms might also keep most of their high value-added operations (such as R&D and newer products) at home, concentrating lower value-added assembly operations in the host nation (Doms and Jensen, 1998; Harris, 1988, 1991b). More recently, it has been

[2] Griffith and Simpson (2001) found that labour productivity was much higher in foreign-owned establishments (using unweighted) ARD data, but an earlier version of this paper produced the incongruous result that TFP was actually much lower in MNE subsidiaries.

argued that it is important to understand that the subsidiaries of some MNE's locate overseas in order partly to source rather than exploit technology (Love, 2003; Driffield and Love, 2007). This is argued to be particularly likely when the industry in the host country is more R&D intensive than the same industry in the country of origin of the MNE. When the motivation for FDI is technology sourcing, it might be expected that such plants will have relatively lower TFP and potentially benefit from 'reverse spillovers'.

To measure whether foreign-owned firms had higher (or lower) levels of TFP, weighted plant-level panel data from the ARD was used to estimate the following standard log-linear Cobb-Douglas production function:

$$y_{it} = \alpha x_{it} + \beta l_{it} + \gamma k_{it} + \delta t + \kappa AGE_{it} + \theta_1 FO_{it} + \theta_2 (FO_{it} \times t_{86-95}) + a_{it} \quad (1)$$

where i and t represent the i -th unit and the t -th year of observation, respectively; y is real gross output; x is real intermediate inputs (i.e., real gross value added less real gross output); l is the number of employees (no data on hours is available); k is plant and machinery capital stock; AGE is the age of the plant (in years); FO is a vector of dummies each taking on a value 1 when a unit is owned by either a U.S., an EU, a SE Asian, an Old Commonwealth or other country enterprise (variables in lower case are logged); and t is a time-index that starts in 1974 (except for the multiplicative term involving FO where we index time to begin in 1986). The advantage of including a separate dummy for each nationality of ownership is that it allows us to detect whether productivity performance significantly varies by nationality. If this is the case, then studies which aggregate all foreign owned firms may miss impacts, and indeed Harris and Robinson (2003) argued it may be that "good" and "bad" nations discount one another, leading to no overall effect.

A dynamic counterpart to Equation (1) was estimated using the dynamic panel-data (DPD) General Method of Moments (GMM) systems approach (Arellano and Bond, 1998), since this is sufficiently flexible to allow for both endogenous regressors (through the use of appropriate instruments – these being the lags of the right-hand-side variables in levels and first differences) and a first-order autoregressive error term. The latter comprises three elements:

$$a_{it} = \eta_i + t_t + e_{it} \quad (2)$$

with the fixed-effect η_i affecting all observations for cross-section unit i ; t_t affects all units for time period t; and e_{it} affects only unit i during period t. All data were weighted to ensure that the samples are representative of the population of U.K. manufacturing plants under consideration and in order to avoid the problem of endogenous sampling, since stratification is based upon employment size and this means that it is likely that the probability of being in the sample is correlated with the variables in the model (particularly ownership attributes and thus productivity) and thus correlated with the model's error term (i.e., $E(z|e) \neq 0$, where z is the vector of regressors in the model).[3]

[3] That is, there is a need to take account of endogeneity, weighting and (where applicable) sample selection effects when measuring the productivity effects and advantages of FDI. On the issue of endogeneity, several authors use the Olley and Pakes (1996) – or OP - approach to measuring

In general across the 20 4-digit manufacturing industries covered Harris and Robinson found that US-owned plants performed better than UK-owned plants although there were two major exceptions (the aerospace and preparation of milk products sectors) and other instances where there is no significant advantage to this sub-sector (in six out of the 20 sectors covered). EU-owned plants outperformed UK-owned plants in only four (of 20) industries; thus overall there is little evidence of a clear productivity advantage of EU-owned plants over domestic plants. Plants owned by the Old Commonwealth countries did better in organic chemicals, mechanical equipment, and printing and publishing of periodicals; and significantly worse in electronic data processing and preparation of milk products (with declining performance over time in the concrete, cement and plaster; and refrigerating equipment industries). Where separate effects could be measured for SE Asian–owned plants, the evidence is mixed: they did significantly better in mechanical equipment and printing and publishing of periodicals; and worse in refrigerating equipment, other electronic equipment and motor vehicles. Only in pharmaceuticals was there any hard evidence that plants owned by enterprises from the rest of the world did any better.

More recent information on whether inward FDI firms have relatively higher TFP is available from Harris and Li (2007), although it is not broken-down by foreign country of ownership. Results are presented (using a two-sided Kolmogorov-Smirnov statistic) of whether the productivity distribution of one sub-group of firms lies to the right of (i.e. dominates) another sub-group. If so, there is shown to be first-order stochastic dominance between such (random) variables, which is a stricter test than simply comparing average productivity levels across sub-groups (for details see, for example, Girma *et. al.,* 2005, and Wagner, 2006, who test the rank ordering of the productivity distribution of firms that differ in their involvement in international markets). Table 1 presents the results obtained by Harris and Li (2007) when applying the Kolmogorov-Smirnov test to data on TFP levels obtained from estimating firm-level panel production functions using *weighted* FAME data for the UK for 1996-2004. Note, the values reported measure the greatest difference between any two sub-groups, and a positive value means that a sub-group lies to the *left* of the opposing sub-group (by definition of the way differences are calculated).

Firstly, Table 1 shows that in every industry examined firms that export had a distribution that lies significantly to the right of non-exporters, and the largest difference between the two distributions was often above 0.2 (and always above 0.14).[4] The table also confirms that the distribution of TFP for foreign-owned

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productivity impacts (e.g. Javorcik, 2004), but there are significant problems with this approach (Ackerberg et. al., 2005, point out a number of issues such as the OP approach does not allow for fixed effects; there is imposed strict monotonicity between investment and productivity, and shocks to productivity are the only unobservable input entering the investment function, ruling out measurement error in these variables; the DPD requires weaker assumptions with respect to e_{it} in equation 2, with OP requiring e_{it} to be uncorrelated with factor inputs at all t; OP requires employment in the production function to be a non-dynamic input (i.e. it has no impact on future profits of the firm, thus ruling out training, hiring and firing costs); and the capital stock is decided in period $t - 1$ (ruling out the use of hired capital assets, and/or incremental additions to capital, during t). with respect to weighting, see Harris (2002) for more details, while sample selection effects will be discussed in section 3.

[4] However, for three industries (financial intermediation; real estate; and other business services) it was also possible to reject the null that the distribution for exporters is more favourable compared to non-exporters. In these industries, exporters dominated non-exporters for a large part of the distribution of

subsidiaries dominated that of UK-owned non-exporters, and that permanent exporters dominated firms that did not export at any time during 1996-2004. The results for foreign-owned firms versus UK-owned exporters show that MNE subsidiaries had a 'better' productivity distribution in less than half of the industries considered while UK-owned exporters dominated foreign-owned firms in 9 out of the 30 industries examined. Lastly, the final set of results in Table 1 suggest that the TFP distributions of foreign-owned exporters were generally to the right of those of foreign-owned non-exporters in a majority of industry groups.

TFP values, but at some level (usually at high levels of TFP) there was a cross-over and non-exporters dominate exporters (see Harris and Li, op. cit., for details and an explanation)

Table 1: Two-Sample Kolmogorov-Smirnov Tests on the distribution of TFP by various sub-groups[a] and industries, UK 1996-2004

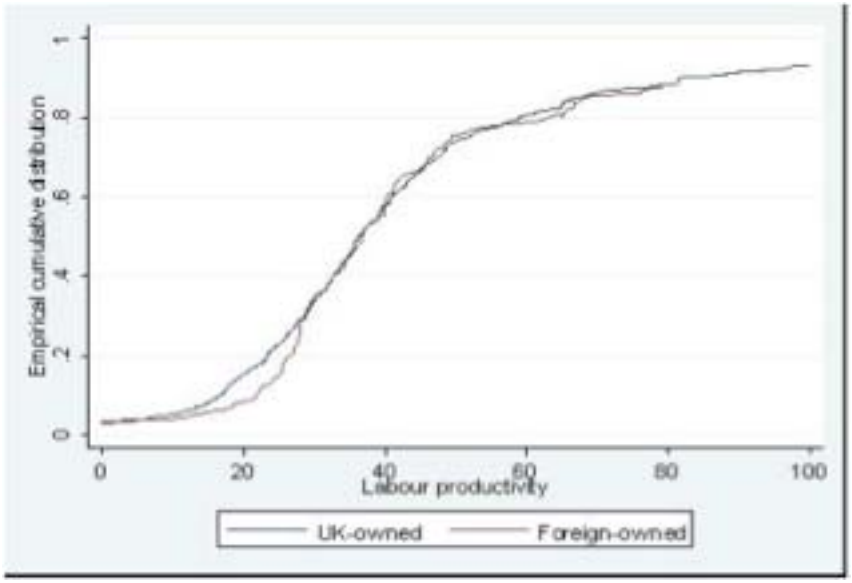
	Difference favourable to:		Difference favourable to:		Difference favourable to:		Difference favourable to:		Difference favourable to:	
Industry (SIC2003 group)	All exporters vs.	All non-exporters	All foreign-owned vs.	UK-owned non-exporters	All foreign-owned vs.	UK-owned exporters	All permanent Exporters vs.	All never exported	FO exporters vs.	FO non-exporters
Agriculture/Forestry/Fish (A/B)	-0.049	0.155**	-0.042	0.188**	-0.006	0.075	-0.049	0.154**	-0.328**	0.002
Food/Beverages/Tobacco (DA)	-0.001	0.241**	-0.002	0.329**	-0.014	0.095**	-0.001	0.259**	-0.029	0.206**
Textiles/Cloth/Leather (DB/DC)	-0.001	0.252**	-0.001	0.338**	-0.005	0.112**	-0.001	0.267**	-0.297**	0.094
Wood products (DD)	-0.004	0.312**	0.000	0.508**	0.000	0.297**	-0.001	0.351**	-0.182	0.610**
Paper/Printing (DE)	-0.004	0.255**	-0.001	0.262**	-0.030	0.023	-0.006	0.273**	-0.031	0.275**
Coke/Chemicals (DF/DG)	-0.013	0.199**	-0.023	0.228**	-0.009	0.056**	-0.028	0.219**	-0.001	0.187**
Rubber/Plastics (DH)	-0.005	0.142**	-0.006	0.207**	-0.020	0.083**	-0.004	0.144**	-0.098	0.014*
Non-metal minerals (DI)	-0.028	0.157**	-0.039	0.185**	-0.133**	0.039	-0.023	0.169**	-0.004	0.196
Basic metals/fabricated (DJ)	-0.002	0.230**	-0.005	0.365**	-0.007	0.204**	-0.002	0.237**	-0.034	0.172*
Fabricated metals (DJ pt)	-0.008	0.215**	-0.012	0.279**	-0.014	0.074**	-0.005	0.240**	-0.018	0.120**
Machinery/Equipment (DK)	-0.002	0.199**	0.000	0.232**	-0.034	0.018	-0.000	0.208**	-0.003	0.105*
Office equip/Radio, TV (DI pt)	-0.026	0.177**	-0.009	0.195**	-0.048*	0.019	-0.037	0.161**	-0.128**	0.058
Electrical machinery (DI pt)	-0.039	0.264**	-0.041	0.280**	-0.030	0.022	-0.041	0.316**	-0.047	0.206**
Medical/Precision (DI pt)	-0.008	0.261**	-0.025	0.345**	-0.029	0.046	-0.010	0.281**	-0.002	0.245**
Motor vehicles/parts (DM pt)	-0.035	0.179**	-0.034	0.232**	-0.038	0.064	-0.003	0.273**	-0.097	0.071
Other transport (DM pt)	-0.033	0.245**	-0.050	0.321**	-0.109*	0.100	-0.038	0.301**	-0.060	0.367**
Manufacturing n.e.c. (DN)	-0.001	0.217**	0.000	0.278**	-0.011	0.070**	-0.001	0.241**	-0.019	0.135**
Construction (F)	-0.008	0.262**	-0.002	0.234**	-0.066**	0.030	-0.010	0.289**	-0.027	0.090*
Repair/sale motors (G pt)	-0.002	0.213**	-0.001	0.337**	0.000	0.221**	-0.002	0.228**	-0.042	0.082
Wholesale trade (G pt)	-0.004	0.186**	0.000	0.211**	-0.020*	0.028**	-0.003	0.207**	-0.016	0.084**
Retail trade (G pt)	-0.001	0.292**	-0.001	0.328**	-0.038	0.057*	-0.001	0.316**	-0.052	0.097**
Hotels/restaurants (H)	-0.009	0.161**	-0.003	0.097**	-0.139**	0.091	-0.024	0.174**	-0.108	0.035
Transport services (I pt)	-0.011	0.276**	-0.001	0.250**	-0.110**	0.080**	-0.015	0.285**	-0.031	0.139**
Support for Transport (I pt)	-0.009	0.178**	-0.008	0.119**	-0.158**	0.007	-0.009	0.218**	-0.076	0.121**
Post/Telecoms (I pt)	-0.011	0.151**	-0.008	0.099**	-0.090**	0.033	-0.011	0.144**	-0.024	0.154**
Financial intermediation (J)	-0.049**	0.220**	-0.030*	0.201**	-0.037	0.037	-0.060**	0.239**	-0.051	0.137**
Real estate (K pt)	-0.083**	0.149**	-0.018	0.074**	-0.144**	0.148**	-0.091**	0.143**	-0.156*	0.137*
Renting (K pt)	-0.017	0.317**	-0.060	0.126*	-0.239**	0.005	-0.016	0.358**	-0.024	0.427**
Computer services/R&D (K pt)	-0.001	0.142**	0.000	0.108**	-0.031*	0.024	-0.001	0.160**	-0.016	0.205**
Other Business services (K pt)	-0.023**	0.220**	-0.022**	0.135**	-0.095**	0.019	-0.027**	0.238**	-0.011	0.198**

Note: ** denotes null rejected at 1% level; * null rejected at 5% level. Source: calculations based on weighted *FAME* (Harris and Li, 2007, Table 3.2)

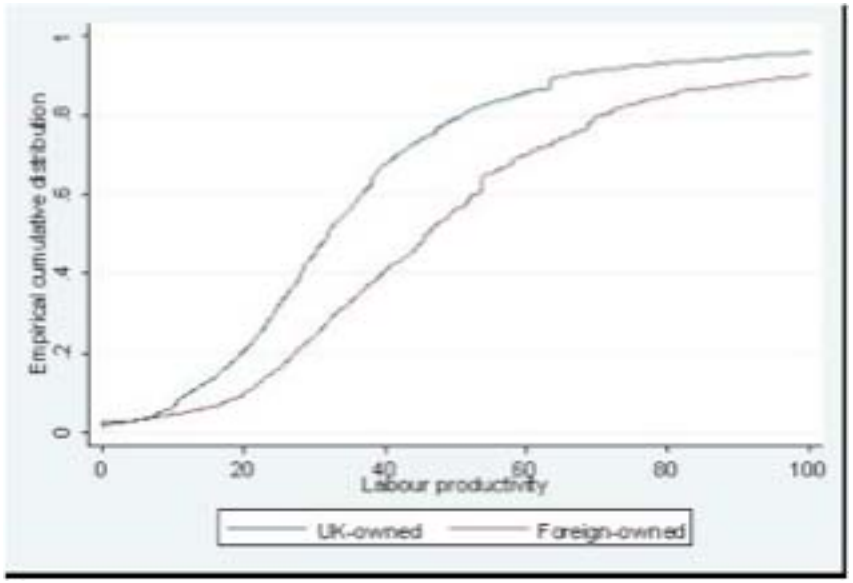
[a] In each instance the test is of the two sub-groups listed against each other, with the null that the distribution of one sub-group dominates the other

Figure 1: Distribution of plant-level labour productivity in 2005.

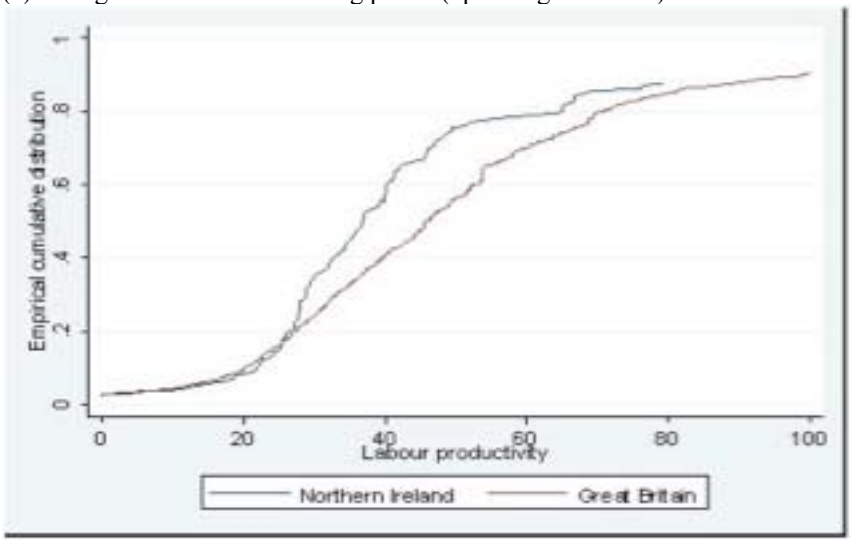
(a) Northern Ireland manufacturing plants (foreign- and UK-owned plants)



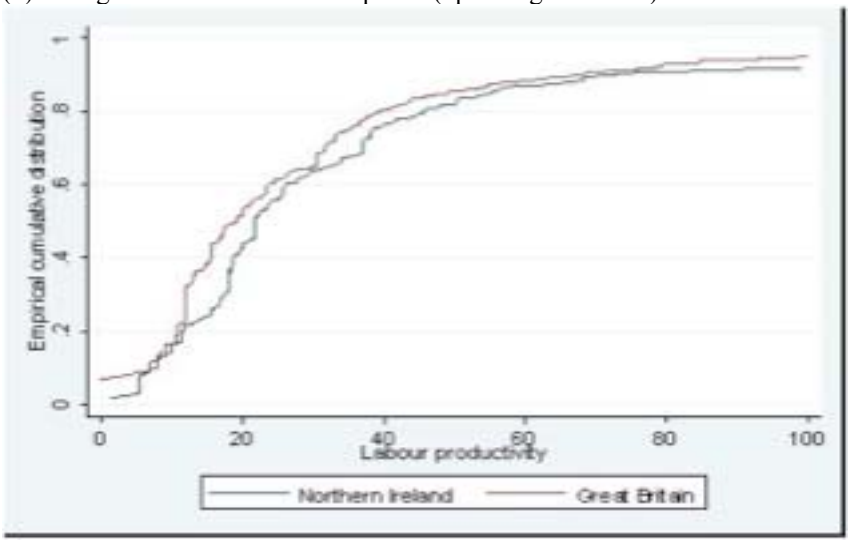
(b) Great Britain manufacturing plants (foreign- and UK-owned plants)



(c) Foreign-owned manufacturing plants (operating in GB/NI)



(d) Foreign-owned service sector plants (operating in GB/NI)

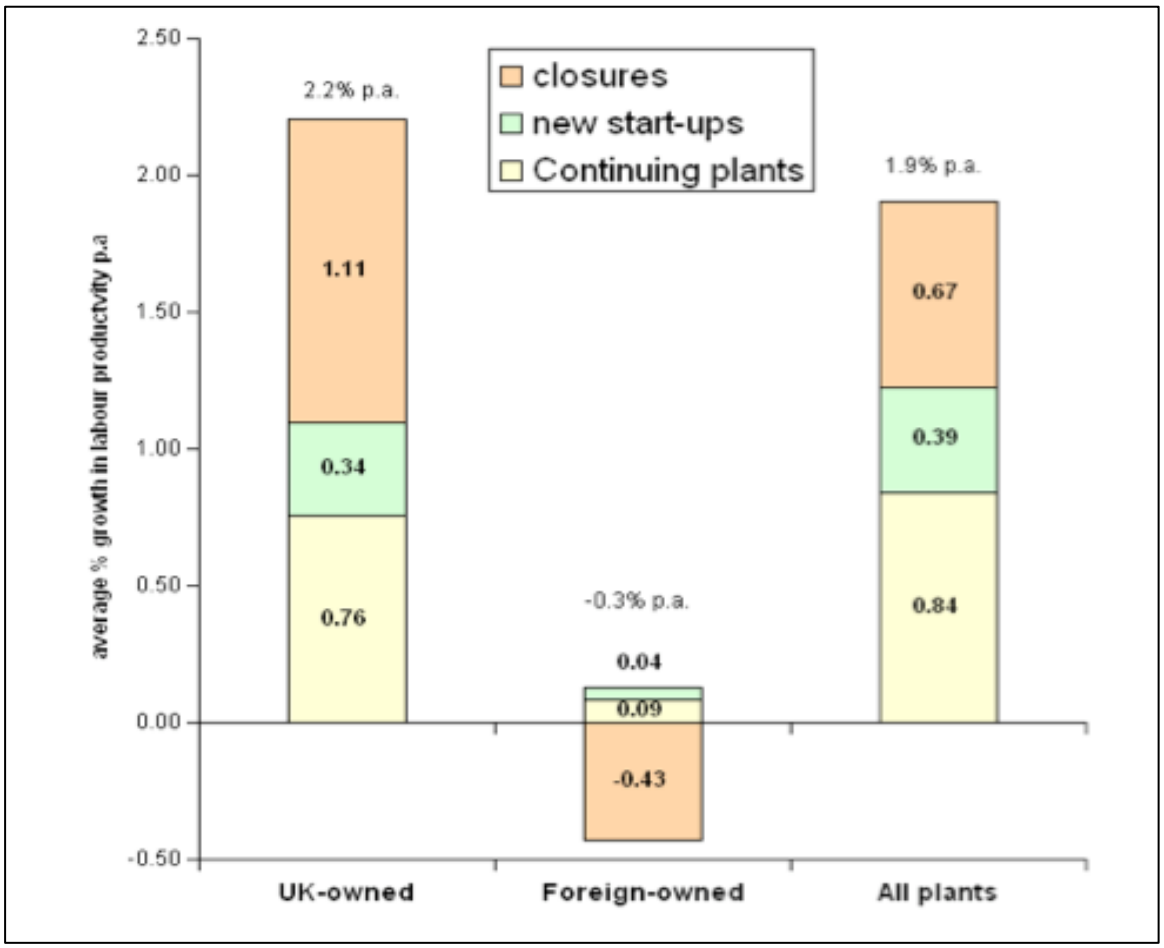


Source: calculations based on the ARD

In summary, Harris and Li (op. cit.) found that FDI plants were generally 'better' than domestic firms that did not export (the largest proportion in most sectors, especially service industries), but there is less clear evidence that FDI firms that do not export have a productivity advantage.

Finally in this section some evidence is presented that suggests foreign-owned plants are not necessarily more productive in certain regions of the UK (e.g., Northern Ireland). Figure 1 shows the distribution of plant-level labour productivity in Northern Ireland and Great Britain in 2005, for various sub-groups. It shows that in the Northern Ireland manufacturing sector, foreign-owned plants generally did not have a (labour) productivity advantage (except perhaps at the lowest levels of productivity), whereas foreign-owned plants outperformed UK-owned plants in manufacturing in the rest of the UK. Hence, in Figure 1(c) there is a clear advantage for those manufacturing MNE subsidiaries that located in Great Britain. Interestingly, labour productivity in foreign-owned service sector plants in Northern Ireland was slightly higher than comparable plants operating in Great Britain, although this is a relatively small sub-sector in both parts of the UK (especially in Northern Ireland).

Figure 2: Growth in market-sector labour productivity in NI, 1998-2006



Source: own calculations based on weighted NI ARD data (all sectors)

3. Direct Benefits from FDI

The direct benefits from attracting MNE's to a host economy are linked to labour market effects (e.g., more and usually better-paid jobs – see Harris, 1991a, 1991b), more R&D expenditure (as foreign-owned subsidiaries tend to be larger in size and often operate in more R&D intensive sectors), and more investment. And, as discussed in the previous section, if they have on average higher levels of productivity then this will increase overall productivity levels in the economy through a 'batting-average' effect, irrespective of whether there are any spillovers from these plants. Of course, if MNE subsidiaries are not better, then they may lower productivity, as seems to be the case in Northern Ireland in recent years (Figure 2). Using the Haltiwanger (1997) approach to decomposing growth into the contributions of different sub-groups of plants (i.e., those that operated throughout the period, plants that opened, and those that closed), and separating out inward FDI plants from UK-owned plants operating in the market sector of Northern Ireland, produces the results reported in Figure 2. Overall there was a 1.9% p.a. growth in productivity between 1998 to 2006, but almost all of this was due to indigenous plants (even though the foreign-owned sector accounted for some 20% of Gross-value Added throughout this period). 'Churning' was a major source of growth but closure of foreign-owned plants lowered productivity growth in the Province as the plants that closed had relatively higher labour productivity.

Direct benefits can also arise from the transfer of technology from overseas-owned MNE's to newly acquired subsidiaries in foreign countries. As with the literature on measuring whether foreign-owned plants are relatively 'better', there have been few studies for the UK that test whether plants that have been acquired through inward FDI become more productive post-acquisition, or whether MNE's 'cherry-pick' the best domestic plants for acquisition with no subsequent improvements in TFP. Harris and Robinson (2002) considered the reasons set out in the literature as to which mode of entry foreign firms might choose: a new (greenfield) site or acquire an existing (brownfield) one. It is argued that the decision will depend on the nature of the MNE's firm-specific advantage(s) and on market conditions; a greenfield site may be less risky if the specific advantage is management of its labour force since this allows the MNE to exploit its advantage through bringing in its own managerial and work practices (and avoid trade unions). In contrast, 'brownfield' acquisitions are favoured if the entrant has little previous experience of producing in the host country or if they are entering a market to manufacture a product not produced at home. Here foreign-owned firms hope to create advantages for themselves through acquiring and internalising valuable assets in the host nation and so they establish capacity by acquiring plants with superior productivity levels and technological characteristics more closer to their own.

Harris and Robinson (op. cit.) also point out that even though they might acquire better plants, post-acquisition MNEs may have problems with assimilation; thus productivity will suffer in the short-run, leading to the overall prediction that: (i) MNE takeovers and acquisitions are of high calibre plants but (ii) there may be a decline in performance in the immediate period post-acquisition. With time, if there is a transfer of technology from the parent MNE, productivity is likely to increase but this presupposes that when testing such a hypothesis there are a sufficient number of

post-acquisition years in which to observe any long-run effects.

The data used by Harris and Robinson (op. cit.) comprised panel data for manufacturing plants drawn from the ARD covering 1982 to 1995. A systems-GMM approach was used to estimate dynamic production functions (for all manufacturing and manufacturing broken-down into three sub-sectors) to compare the total factor productivity characteristics of those plants that changed ownership during 1987-1992 (panel data for 1982-1986 and 1993-1995 periods are also used to establish pre- and post-acquisition periods, but only those plants that existed during all or some part of 1987-1992 were retained in the analysis). There were eight sub-groups that spanned the entire data set: (1) those plants that were foreign-owned throughout 1982-1992 (some 2.7% of the observations in the data set); (2) UK-owned, single-plant enterprises (14.1% of observations); (3) those plants that did not change ownership during 1982-1992 and were owned by UK multiplant firms that sold plants to the foreign-owned sector during 1982-1992 (13.4% of observations); (4) those plants that were acquired by UK-owned enterprises during 1982-1986 (15.1% of observations); (5) those plants that were acquired by foreign-owned enterprises during 1982-1986 (1.5% of observations); (6) those plants that were acquired by foreign-owned enterprises during 1987-1992 (3.4% of observations); (7) those plants that were acquired by UK-owned enterprises during 1987-1992 (19.1% of observations); and (8) those plants that did not change ownership during 1982-1992 and were owned by UK multiplant firms that did not sell plants to the foreign-owned sector during 1982-1992 (30.7% of observations).

Table 2: 'Sub-group' Dummies of the Weighted Estimates of Dynamic Cobb-Douglas Production Function

Dependent variable: ln Gross output	All manufacturing	
	par. est.	*t*-value
FO 1982-92	0.208	2.27
UK single plant 1982-92	-0.461	1.99
UK enterprise sold to FO sector	0.317	2.82
Changed owner 1982-86 but not to FO	0.384	2.97
Changed to FO 1982-86	0.329	2.22
Change to EU 1987-92	0.345	2.83
Change to US 1987-92	0.383	3.10
Change to RoW 1987-92	0.345	2.83
Changed owner 1987-92 but not to FO	0.202	1.73

Benchmark sub-group: plants not changing ownership belonging to UK owned multi-plant enterprises not selling plants to the FO sector.

Source: Harris and Robinson (2002, Table 1)

The results for all manufacturing plants are shown in Table 2 indicating that plants belonging to foreign-owned enterprises were generally more productive throughout the 1982-1995 period, especially those acquired between 1987 and 1992 (which were over 24 to 72 per cent more productive across the various industry sectors). In addition, plants that were acquired during 1987-1992 by the UK-owned sector (whether from internal UK-to-UK transfers or purchases of foreign-owned plants) were usually more productive than the benchmark sub-group, but by a margin

considerably less than that displayed for foreign-owned acquisitions. Overall, overseas MNE's tended to have higher TFP and to acquire "good" plants (i.e. they "cherry-picked"). As to whether the inherent higher productivity of acquired plants was maintained post-acquisition, the picture is rather mixed but overall suggests that post-acquisition productivity tended to decline slightly and more particularly for those plants acquired during 1987-1992 by UK-owned enterprises.

As pointed out by Girma et. al. (2007), a short-coming with the Harris and Robinson (2002) study is that potential sample-selection bias was not controlled for, particularly with respect to whether the acquired plants were engaged in exporting (Girma et. al., op. cit., claim that over 80% of all foreign acquisitions of UK manufacturing firms from 1988 to 1996 had some experience of exporting). That is, if MNE's with their headquarters outside the UK were selecting plants for acquisition based on a number of pre-acquisition characteristics (particularly productivity, which is generally higher in exporting firms – see section 2), then such plants would be expected to have had higher levels of post-acquisition productivity even if they had not been acquired, and therefore failure to control for this selectivity is likely to bias upwards any estimates of the genuine impact of FDI on post-acquisition productivity levels.

Thus, Girma et. al. (2007) use a matching approach to compare the post-acquisition performance of exporting firms that were acquired by MNE's with a control group of non-acquired UK-owned exporters that had comparable characteristics (which are correlated with pre-acquisition productivity levels). They use an unweighted sample from the OneSource database and find that acquired firms experience a boost in TFP in the year of acquisition and one year after, but this is largely dependent on having higher pre-acquisition productivity (a proxy for the firm's ability to assimilate or absorb any transfers of knowledge from the parent MNE). Moreover, two years after acquisition there is a compensating fall in productivity such that three years post-acquisition the productivity growth of firms that were acquired by overseas-owned MNE's reverted to being much the same as for those domestic exporters that were not acquired.

Clearly controlling for sample selectivity effects (presumably assisted by concentrating on only exporting firms) is an improvement on the methodology used by Harris and Robinson (2002) to measure whether there are further post-acquisition gains for those firms that are "cherry-picked" by foreign-owned firms. However, a major drawback with the Girma et. al. (op. cit.) study is their measurement of TFP, which is obtained outside their modelling approach through use of growth-accounting techniques (which among other restrictive assumptions include that markets are perfectly competitive). Thus they do not allow the ownership (or other TFP enhancing) characteristics of the firm to be jointly modelled with acquisitions, which is likely to bias their estimates of TFP. Indeed as they select their control group (and estimate the size of the post-acquisition change in TFP) using pre-acquisition estimates of TFP (which ignore the full range of determinants of TFP), it is likely that any estimates of the direct impact of FDI on acquired firms is (considerably) biased upwards.[5] Another issue with their approach is using unweighted data, which is

[5] That is there is an omitted variable problem. The first-step (growth-accounting or any technique that only includes information on output less factor inputs) produces estimates of TFP that ignores other known determinants of output such as ownership effects (which are subsequently shown to be statistically significant); here standard econometric theory says that these estimates of TFP will be

known to be highly biased towards larger firms. Whether their results would carry over when a more nationally representative sample is used is unknown.

Lastly, direct benefits can also arise from transfers of technology to the subsidiaries of UK-owned MNE's from their learning in overseas markets, which can then lead to higher productivity in their domestic operations (with potential spillovers to other non-MNE domestic plants). As Herzer (2008) argues, the benefits are not just technological: "… outward FDI allows firms to enter new markets, to import intermediate goods from foreign affiliates at lower costs, to produce a greater volume of final goods abroad at lower cost, and to access foreign technology… (thereby combining) home production with foreign production to reduce costs and to increase their competitiveness both internationally and domestically". Using country-level panel data on GDP and net outward flows of FDI for 1971-2005 covering the 14 most developed economies in the OECD (including the UK), Herzer (op. cit.) found that outward FDI had positive long-run effects on domestic output, but that this also allowed firms to invest more abroad and thus increase outward FDI.[6] Driffield et. al. (2005) used a panel of 13 countries and 11 manufacturing sectors for 1987-96 (accounting for 87% of the outward FDI flows from the UK during the period 1990-98), finding that outward FDI did raise domestic productivity in the UK. However, the latter also rose when certain outward FDI sectors from the UK concentrated on sourcing lower value-added activities abroad where unit labour costs were lower (thus producing a 'batting average' effect through lowering costs for these sectors). This suggests that not all the benefits from outward FDI are based on technology gains.

4. Spillovers from FDI

As pointed out in Harris and Robinson (2004) the term 'spillovers' is often not well-defined; it is meant to represent the residual benefits from FDI which accrual to indigenous firms/plants and for which foreign-owned firms are uncompensated, raising the overall level of productivity. The various types of spillovers are based on different types of externalities, according to how they are mediated. Scitovsky (1954) and then Griliches (1979, 1992) distinguished between pecuniary (also called vertical, welfare or rent) externalities, which are based on market transactions, and non-pecuniary (also called horizontal, knowledge and technological) externalities which are based on non-market interactions usually involving the sharing of knowledge and expertise. The first type usually depends on buyer-seller linkages and occurs because quality improvements in inputs and outputs are not fully appropriated and thus are not entirely reflected in the price of such goods and services. Thus recipients of these welfare enhancing externalities experience a cost-reduction and a subsequent rent

biased by such an omission. Moreover, the estimates obtained in the second-step regression will also be biased (see Wang and Schmidt, 2002, section 2.3 for an explanation). Wang and Schmidt (*op. cit.*) show that in the case of two-step estimators of technical efficiency using the stochastic frontier production function approach, simulations indicate that bias due to the omitted variable problem is substantial. It is almost certain that their results extend to the present discussion of two-step estimation of the determinants of TFP.

[6] However in a separate paper Herzer and Schrooten (2008) found that in the US outward FDI had positive effects on domestic output, but in Germany this complementary relationship breaks down in the long-run (although it is present in the short-run).

Table 3: Typology of Spillovers

Transmission mechanism	Effect	Likely Impact
Intra-industry		
Demonstration effects	Imitation of FDI products and processes; licensing of new technology	+
	Difficulties in absorption of new technology due to lack of technological complementarities	–
Competition effects	Reduction in costs/inefficiency in order to respond to entry (threat)	+
	FDI market share pushes domestic firms up their average cost curves	–
Labour Market	Hiring of FDI-trained staff with improved human capital.	+
	Domestic firms mismatch between current capabilities and human capital of FDI-trained staff	–
Inter-industry		
Forward linkages	Technology transfer and/or new management practices (HRM/JIT) to upgrade quality/lower cost of products demanded by upstream FDI	+
	Difficulties in absorption of new technology/practices; less efficient domestic firms are 'crowded-out'.	–
Backward linkages	Purchase of improved intermediate products; technological upgrading of own products	+
	Difficulties in absorption of new technology/products; rising costs of domestic suppliers (due to FDI competition) are passed-on	–
Agglomeration		
Labour Market	Pool of FDI-trained workers available to local labour markets; increase in entrepreneurial activity (new firm formations)	+
	'poaching' of better staff to FDI (higher pay and career development offered); upward pressure on wage costs	–
Infrastructure	Access to greater range of business services (especially R&D which is attracted to service FDI); intra/inter-industry effects stronger in cluster (diminish over space); minimisation of transport costs	+
	Higher costs (e.g. premises); congestion; 'crowding out' due to FDI competition for local resources	–

Source: Harris and Robinson (2004), Table 1.

gain. As explained by Koo (2005), such pecuniary externalities are associated with intermediate inputs and labour pools. They are also emphasised in new economic geography models, where 'black-box' technological externalities are generally omitted (Neary, 2001, p. 550) and where instead the "…intensity (of pecuniary externalities) can be traced back to the values of fundamental microeconomic parameters such as the intensity of returns to scale, the strength of firms' market power, the level of barriers to goods and factor mobility" (Ottaviano and Thisse, 2001). In contrast, technological (or knowledge) externalities are disembodied from new goods and services (and thus direct input-output linkages) and instead arise when firms share a general pool of knowledge, which can shift their (and thus the economy's) production possibility frontier (unlike pecuniary externalities which usually help firms to move to/along the existing production frontier). To complicate matters, in empirical studies it is often difficult to separate out pecuniary from non-pecuniary externalities, partly because of the lack of adequate proxy measures and partly because spillovers can embody both types of externalities. For example, common labour pools can be a source of pecuniary externalities (e.g., allowing firms to engage in efficient labour sorting at lower cost), and a source of knowledge sharing (e.g. when similar firms engage in R&D to solve similar or related problems).

Thus, the literature on FDI spillovers tends to group spillovers into types, which can be proxied by measures directly associated with each type. Thus there are intra-industry spillovers (measured by the share of industry output, labour or capital produced by FDI plants); inter-industry spillovers (proxied by FDI 'presence' in upstream and downstream industries that buy and sell to domestic firms in a particular industry); and agglomeration spillovers (measured by the share of output produced by FDI plants in a particular location). Table 3 (taken from Harris and Robinson, 2004, Table 1) sets out a typology of spillovers using this approach (see also Figure 1 in Potter et. al., 2002). While it is not meant to be comprehensive, it broadly captures the majority of spillovers as represented in the FDI literature in this area.[7]

The outcome from estimating models of FDI spillovers has generally been results that are inconclusive or difficult to interpret. For example, Harris and Robinson (2004) considered 20 important manufacturing industries and used weighted ARD data to measure all three types of spillovers as represented in Table 3. They measured FDI 'presence' by grossing-up estimates of plant-level capital stock to get: (i) the percentage of industry capital stock located in foreign-owned plants (intra-industry); (ii) the percentage of capital stock located in each local authority area (agglomeration); and (iii) the percentage of capital stock in foreign-owned plants in up to *n* input-output linked industries (inter-industry). Using A GMM-systems approach, the results obtained are set out in Table 4. In over one-third of the industries covered, there was no statistically significant evidence of an *intra-industry* effect on domestic plants. For those industries where there was an impact, some are positively affected by foreign-owned plants and in others the competition effect of foreign ownership was presumably stronger leading to an overall negative impact. As to agglomeration effects Harris and Robinson (op. cit.) found no evidence of any spatial spillovers on two-thirds of the industries covered (including no evidence of agglomeration economies in the high-tech electronics industries). Inter-industry spill-

[7] More is said about agglomeration spillovers in the next section, where we consider the extent to which geographical proximity affect the size of any spillovers.

Table 2: Summary of Weighted System Estimates of Spillover Effects
[based on Cobb-Douglas Production Function, 1974-1995: UK Manufacturing (various industries)].

Type of Spillover	Steel Wire (SIC2234)	Concrete, cement, plaster (SIC2437)	Ceramic goods (SIC2489)	Organic chemicals (SIC2512)	Pharma-ceutical products (SIC2570)	Engineers' small tools (SIC3222)	Mechanic-al equipment (SIC3255)	Refrigerat-ing machinery (SIC3284)	Electronic data processing (SIC3302)	Other electronic equipment (SIC3444)
Intra-industry	n.s.	+	n.s.	+	–	–	–	n.s.	+	n.s.
Agglomeration	n.s.	–	n.s.	–	+	n.s.	+	n.s.	n.s.	n.s.
Forward (+ive)	3	3	2	7		2	4	2		1
Forward (-ive)	5	2	1	2		3	1	3		
Backward (+ive)	2		2	2	4	10	8	2	1	
Backward (-ive)	1	1	3	4	1	10	2	3	1	2

Type of Spillover	Electronic sub-assemblies (SIC3453)	Motor vehicles and their engines (SIC3510)	Aerospace equipment (SIC3640)	Preparation of milk products (SIC4130)	Cocoa, etc. confection-ery (SIC4214)	Miscellan-eous foods (SIC4239)	Packaging of paper and pulp (SIC4724)	Print/pub-lishing of periodicals (SIC4752)	Plastics semi-manufact-ures (SIC4832)	Other manufact-ures n.e.s. (SIC4959)
Intra-industry	+	n.s.	+	+	–	–	–	–	n.s.	n.s.
Agglomeration	n.s.	n.s.	n.s.	+	–	n.s.	n.s.	–	n.s.	n.s.
Forward (+ive)	2			3	1	2	1	3	3	1
Forward (-ive)	2			4		5	1	2	3	3
Backward (+ive)	2	2	2	2	2	4	3	3	5	3
Backward (-ive)	4	1	2	4	2	2	1	2	2	4

+ = positive effect; – = negative effect. All parameter estimates are significant at the 5 per cent level (or better)
n.s. not significant at 5 per cent level. Individual numbers represent the number of industries with significant parameter estimates.

Source: Harris and Robinson (2004), Table 2.

overs seemed to be particularly important in some industries; however, there was no clear pattern in terms of which industries experienced spillovers, the extent of these (in terms of the number of industries linked), and the balance between positive and negative spillovers.

Other (more) recent studies of spillovers have looked at factors omitted in the Harris and Robinson study, which are likely to be relevant when modelling spillover impacts. These include: the importance of absorptive capacity; sub-dividing firms/plants by whether they export or not; and taking account of the different motivations for MNE's locating in host countries (in particular whether they are embarked on technology sourcing or exploiting). Each of these is considered below.

An important element in the extent to which spillovers result in positive or negative impacts on indigenous plants relates to the ability of such plants to be able to internalize the benefits available (cf. Table 3). Thus with respect to intra-industry demonstration effects, or inter-industry technology transfers, plants with low levels of absorptive capacity may not be able to integrate new technology or new knowledge within their existing practices. In such instances it is expected that spillover effects either do not show up, or are negative (the latter may occur, as discussed in Aitken and Harrison, 1999, since firms with low absorptive capacity are exposed to a negative competition effect as they compete with MNE subsidiaries, but have insufficient means to internalise any spillover benefits from such firms).[8] The importance of some measure of absorptive capacity to mediate between FDI 'presence' and productivity spillovers has featured in a number of papers, particularly in the work of Sourafel Girma in the UK. For example, Girma and Wakelin (2002) found that regional spillovers were only significant for firms in sectors with a low technology gap between foreign and domestic firms (where the gap is measured as the difference in relative TFP between domestic and foreign owned firms, with 'low gap' defined as a relative productivity advantage to foreign firms of 15% or less). Girma and Gorg (2005, 2007) report that the link between increases in FDI presence in an industry and domestic firm productivity increases is U-shaped, rationalising this the counteracting effects of positive spillovers and negative competition effects. They argue that firms with the lowest levels of absorptive capacity are unlikely to be in direct competition with MNE subsidiaries and therefore do not experience negative competition effects; however they also recognise that such firms are unlikely to absorb any (technological) spillovers from foreign-owned firms. Presumably, therefore, they benefit from pecuniary externalities (linked to cost reductions – see above).

In contrast, Haskel et. al. (2004) found "…weak evidence that this TFP/foreign-affiliate correlation is stronger for plants that are smaller and less technologically advanced, which might suggest that spillover accrue predominantly to "lagging" domestic plants, not "leading" ones" (p.4). However, they provide no rationale for their results and it may be that using different data (unweighted data from the ARD rather than OneSource) and different techniques (OLS estimation of a production

[8] This is an older interpretation of the role that 'backwardness' has for the speed of adoption of new technologies and thus potential spillover benefits from MNE's. Early literature suggested that the larger any (productivity) gap, the greater the opportunity to 'catch-up', but this is usually predicated on a neoclassical view of the world where there are few barriers to 'catch-up' (such as differences in firm-based assets – linked to knowledge creation intangible assets – which impact on the ability of firms to absorb new knowledge – se Harris, 2008, for details).

function versus a second stage quantile regression of the determinants of TFP in the later studies by Girma) may provide some of the explanation.

More recent studies have concentrated on sub-dividing firms/plants into exporters and non-exporters, based in part on the expectation that domestically-owned exporters will have higher levels of absorptive capacity (which helps exporters overcome both the sunk costs of entry into overseas markets, and also potentially benefits them from a 'learning-by-exporting' effect – see Greenaway and Kneller, 2005, Table 1, and Greenaway and Kneller, 2007, Table 3, for a review of this literature). Thus, spillover effects from FDI may mostly accrue to exporters, particularly by helping firms internationalise. In addition, foreign-owned firms are divided into those that export and those that sell only to firms in the host economy, with an additional expectation that (export) spillovers from FDI may be larger in MNE subsidiaries who also export. Kneller and Pisu (2007) concentrate on whether there are significant export spillovers from the operation of foreign affiliates in the UK, finding that FDI firms that export in the same industry have positive and significant impacts on the decision of domestic firms to participate in export markets; and FDI firms (whether they export or not) who supply to domestic firms[9] have a positive impact on the export intensity of these domestic firms. Girma et. al. (2008) take a more general approach in that they too sub-divide indigenous and foreign firms into exporters and non-exporters, but they then look at whether there are general productivity spillovers (and not just export spillovers) arising from such linkages. Again they use (unweighted) UK data from OneSource (supplemented by data from UK Input-Output tables to establish the strength of buy-sell linkages across industries), and find that domestic exporters (but not non-exporters) experience positive intra-industry spillovers (which increase with higher levels of absorptive capacity) but only from export-orientated MNE subsidiaries. In terms of backward linkages, Girma et. al. (op. cit.) find that domestic market-orientated MNE's who sell to UK firms impart positive spillover impacts which increase with absorptive capacity; while export-orientated MNE's have a (small) negative (i.e., market-stealing) impact on productivity in domestic firms (which increases with absorptive capacity). In all their study points to the need to take into account the export orientation of domestic and foreign firms when looking for productivity spillovers.

The motivation for inward FDI is also important in understanding spillover effects. If such firms have a comparative advantage (compared to firms in the host region) that they wish to exploit, then to the extent that this cannot be fully appropriated by the MNE there is a possibility of spillover impacts. However, if inward FDI is to access the proprietary technology and knowledge of indigenous firms, then such technology sourcing is more likely to be associated with negative spillover impacts (here MNE subsidiaries benefit from reverse spillovers and presumably can steal market share from indigenous firms). Driffield and Love (2007) combine this dichotomy over the use of technology with another major reason why FDI occurs: for locational advantage. The latter is proxied by relative unit labour costs, such that locating production facilities in a host region which has relatively lower costs (compared to the source region) will lower overall production costs for the MNE. Using panel data for

[9] Direct information on whether there were actual backward linkages between domestic firms and MNE subsidiares was not available; rather the relative strength of inter-industry linkages (as measured in UK Input-Output tables) was used to weight FDI 'presence' in backward and forward industries to obtain a proxy measure for the potential trade in intermediate goods between FDI and domestic firms.

30 countries from which the UK received FDI during 1987-1997, Driffield and Love (op. cit.) consider productivity spillovers at the level of 2-digit manufacturing industries. FDI was categorised into 4 sub-groups depending on whether R&D intensity was higher/lower in the host/source sector (leading to technology sourcing or exploitation) and/or whether unit labour costs were higher/lower. Using a GMM-systems approach, they found that FDI that was technology sourcing *and* exploiting a locational advantage resulted in a negative spillover effect on domestic productivity. In contrast, domestic firms in the UK experienced positive spillovers from FDI that was exploiting superior technology (but not lower unit labour costs in the UK). There were no significant impacts from FDI that engaged in technology sourcing and originated from a country with lower unit labour costs; and no impact from FDI with superior technology and higher unit labour costs in the country of origin.

Other studies also suggest that separately out technology sourcing FDI from technology exploiting is important. Girma and Gorg (2005, 2007) considered the impact of FDI in the UK electronics and engineering sectors, finding that for firms in the latter sector spillover effects were negative (except for those domestic firms with the highest levels of absorptive capacity). Since data shows that R&D activity in the UK engineering sector is greater than R&D intensity in corresponding sectors in FDI source countries, this suggests that much FDI into this UK sector is for technology sourcing purposes.

In all, the importance of technology sourcing versus technology exploitation suggests that there is a need to take account of this difference to help interpret the results obtained when modelling spillovers, and to motivate the researcher to avoid potential endogeneity problems that would arise if foreign firms are attracted to regions and/or industries with high productivity (which is likely if technology sourcing is occurring and spillovers flow in both directions) or to regions/industries with lower productivity (where technology can be exploited).

In terms of the measurement of FDI 'presence' in studies of spillovers, every study using UK micro-panel and industry-level data rely on aggregating FDI firms/plants to obtain proxies of the potential sources of such spillovers, with input-output data used to weight 'presence' for forward- and backward-linked industries.[10] The lack of direct measures of linkages is a problem that is unlikely to be solved in the near future, unless more dedicated data are collected (by government) to produce this missing information. The short-run alternative is survey-based work (e.g. Potter et. al., 2002) which involves asking firms that trade and/or network with each other what are the sources of spillovers and how large are such effects. The major problem with studies of this type is that they are hard to generalise (being based on typically very small samples); they require respondents to be able to separate out complex cause-and-effect mechanisms that are linked to productivity; and they typically do not involve the use of 'control' groups that have similar productivity characteristics but are not linked to MNE subsidiaries.

[10] Some studies only consider intra-industry spillovers, and the extent to which inter-industry and/or agglomeration spillovers are important and yet omitted will have implications in terms of what any intra-industry proxies are measuring.

There are a number of different underlying methodologies used to measure spillovers. A significant number of studies use measures of TFP that are derived in a first-stage model, and then explained in a second-stage that includes spillovers from FDI as a potential determinant. As explained above, this is very likely to lead to biased and inefficient estimates. Many studies do not take account of endogeneity between the variables in the model, which also will lead to biased results. And, lastly, most studies use data that is often significantly skewed towards large firms/plants and is therefore not representative.

Table 5 **Net percentage contribution of spillover effects[a] to output (1974–95)**

SIC	Industry	% contribution of spillovers to gross output	% contribution from intra-industry spillovers	% contribution from agglomeration spillovers
2234	Steel wire	31.1	0.0	0.0
2437	Concrete, cement, plaster	48.7	12.3	–2.7
2489	Ceramic goods	–48.9	0.0	0.0
2512	Organic chemicals	65.0	7.0	–0.7
2570	Pharmaceutical products	–4.2	–3.7	–1.1
3222	Engineers' small tools	–37.1	–54.5	0.0
3255	Mechanical equipment	62.0	–33.3	1.8
3284	Refrigerating machinery	36.4	0.0	0.0
3302	Electronic data processing	49.4	35.8	0.0
3444	Other electronic equipment	0.5	0.0	0.0
3453	Electronic sub-assemblies	–36.7	83.3	0.0
3510	Motor vehicles & their engines	–0.5	0.0	0.0
3640	Aerospace equipment	26.6	5.6	0.0
4130	Preparation of milk products	49.8	9.9	0.0
4214	Cocoa, etc. confectionery	33.6	–2.5	–1.0
4239	Miscellaneous foods	–60.7	–57.3	0.0
4724	Packaging of paper and pulp	34.4	–5.0	0.0
4752	Print/publishing of periodicals	99.7	–3.8	–2.3
4832	Plastics semi-manufactures	–125.1	0.0	0.0
4959	Other manufactures n.e.s.	295.0	0.0	0.0
Total		13.0	–5.5	–0.3

Source: Harris and Robinson (2004, Table 3)

Finally, despite the various approaches (and associated caveats) to measuring spillovers, does UK empirical work find them to be important? Haskel et. al. (2004) suggest that overall a 10% increase in FDI in a UK manufacturing industry raises TFP in domestic plants by about 0.5%. The impact of the different types of spillover as measured in Girma et. al. (2008) are significantly larger – for example, a domestic exporter with a median level of absorptive capacity experienced a 1.2% increase in TFP following a 1% increase in intra-industry export-orientated FDI. Driffield (2004) reports an overall elasticity for intra-industry, inter-industry and agglomeration spillovers that suggests overall a 10% increase in FDI in a UK non-assisted area raises TFP in domestic plants by about 0.6%. The median marginal effect of an increase in FDI in the UK electronics and engineering industries is around 0.006 and –0.015, respectively (Girma and Gorg, 2007); and Driffield and Love (2007) suggest that the marginal spillover effect from technology sourcing FDI in the UK is –0.018, and for technology exploiting it is around 0.022. Finally Harris and Robinson (2004) estimated that overall 13% of the gross output of plants in the 20 manufacturing industries covered was attributable to spillover effects across 1974-1995 (see Table 5).

5. Clustering and Spillovers from FDI

This section covers two main questions: are FDI spillovers more likely in locations where firms/plants co-locate (i.e., cluster); and are MNE's more likely to locate their production facilities in such (pre-existing) clusters? The literature on agglomeration economies of scale tends to emphasise the type of localisation externalities discussed in Marshall (1890), Arrow (1962), and Romer (1986) – hence the term MAR-spillovers. Such spillovers minimise transport and transaction costs for goods, people, or ideas, and thus to benefit from them suggests that firms within a specific industry locate near other firms along the supply chain (be they customers or suppliers); locate near other firms that use similar labour; and/or locate near other firms that might share knowledge (Ellison, *et. al*., 2007). MAR-spillovers are associated with industrial specialisation and are to a large extent an intra-industry phenomenon.

Clearly firms locate in close proximity to reduce the costs of purchasing from suppliers, or shipping to downstream customers. Co-location is also likely if there is a large, common pool of labour, to maximise the 'fit' between productivity levels in firms and workers, and to facilitate workers acquiring industry-specific skills (human capital), since the risk of not being able to appropriate the returns from training are lower where there a large(r) number of potential employers. Lastly, firms may co-locate to obtain knowledge spillovers that occur when similar firms engage in, say, R&D to solve similar or related problems. Physical proximity (and density) speeds the flow of ideas, especially when a significant part of intangible knowledge is often tacit (and therefore difficult to codify), and (social) networks tend to be strong.

As well as MAR-spillovers leading to specialisation and thus industrial districts and agglomerations, spillovers can also result from urbanisation externalities due to the size and heterogeneity (or diversity) of an (urban) agglomeration. These are labelled Jacobian spillovers (Jacobs, 1970, 1986), and they result when different industries benefit from economies of scope (rather than scale). A greater range of activities (e.g.

R&D, business services, cultural and lifestyle amenities, and the overall quality of the public infrastructure – cf Florida, 2002; Glaeser *et. al*., 2001) leads to inter-industry spillovers. (Larger) firms – and especially multinationals – tend to locate their head office management and R&D functions in urban agglomerations. Thus these agglomerations not only tend to generate more product innovations, but there is more likelihood of spin-offs and/or start-ups, which creates a thicker entrepreneurial culture.

The evidence on whether FDI spillovers are more likely in clusters is limited to those UK studies that have included measures of agglomeration spillovers.[11] Using panel data from the ARD, Harris and Robinson (2004) found very little evidence of such impacts, using measures of FDI presence at the local authority level (see Table 5 above). Driffield (2004) used manufacturing industry by regional data for 1984-1997 covering around 20 sectors and 11 regions, finding that in those regions mostly classified as Assisted Areas there was no evidence of any regional spillovers (and only a negative intra-industry effect presumably due to domestic plants loosing market shares). De Propris and Driffield (2006) extended Driffield's earlier study to include potential spillovers from domestic-to-foreign owned firms as well, while the spatial unit of analysis changed from region to clusters identified at the travel-to-work level. The results for spillovers from FDI showed that those regions with significant clusters overall experienced significant positive spillovers; those with no clusters experienced overall significant negative spillovers (or what the authors called 'crowding out' effects). Similar results were obtained when estimating 'reverse' spillovers from domestic to FDI firms. Thus in clusters there was evidence that FDI firms were engaged in both technology exploitation and sourcing, but outside these clusters productivity was adversely affected through intra- and inter-firm competition effects. Given the similarity in the results from Driffield (2004) and De Propris and Driffield (2006) for inward FDI, it might be presumed that non-assisted areas can be most closely identified with the cluster regions, while assisted areas match with the no cluster regions.

These results are not corroborated by the survey work undertaken by Potter et. al. (2002); while they found that spillovers occurred at both a region and national level, they did not find FDI having a poorer impact in Assisted Areas. However, given the issues raised above regarding the survey approach, these results should be treated with more caution.

As to whether MNE's are more likely to locate their production facilities in (pre-existing) clusters, the most relevant studies for the UK are Duranton and Overman (2006), Devereux et. al. (2007) and Simpson (2007). These studies find there is a tendency for foreign-owned plants to co-locate their subsidiaries with other foreign-owned activity; that such MNE plants have similar location patterns to UK-owned plants (Simpson reports that the correlation between the agglomeration indices for foreign and domestic owned plants is 0.4); and agglomerations are more likely in the London area, followed by the South East of England.

Clearly these findings (that spillovers are more likely in clusters; FDI tends to co-locate in such pre-existing areas; and clusters are more likely to be found in non-

[11] Most of the literature in this area does not attempt to measure agglomeration spillovers using spatial econometric techniques (see Anselin, 2007, for an overview). Rather there are a number of rather ad hoc approaches to measuring spatial spillovers in the literature that are reviewed in Harris and Kravtsova (2009).

assisted regions) have a number of policy implications which will be discussed in the conclusions section.

6. Trade versus FDI Spillovers

There is a large and well-established literature that shows that technology is transferred through trade as well as FDI, especially through importing intermediate and capital goods that embody new technology and by 'learning-by-exporting' products that imitate other countries' technology (see Harris and Li, 2006, section 2 for a review). Moreover, as pointed out by Acharya and Keller (2008), international trade often changes the intensity of competition and leads to productivity selection whereby the least productive firms are much more likely to loose out (see for example the models developed by, for example, Clerides et. al., 1998; Bernard et. al., 2003; and Melitz, 2003). In addition, McVicar (2002) makes the point that "… studies that ignore either goods trade or FDI are likely to both overstate the importance of what is included and understate the overall size of international spillovers" (p. 297).

Zhu and Jeon (2007) used panel data for 21 OECD countries for the period from 1981 to 1998, finding that international trade was a more important channel for R&D spillovers than was inward FDI (while outward FDI was only marginally significant). Acharya and Keller (2008) undertake a similar study using OECD data and a knowledge production function approach, but their emphasis is on comparing the relative importance of technological spillovers and productivity selection through imports, finding both are important. However, if there is low absorptive capacity in the host country, imports tend to increase competition and therefore are more likely to lead to lower productivity (as domestic firms loose market shares); in contrast, if absorptive capacity is high and imports are relatively technology-intensive, they find that imports raise the productivity of domestic firms.

7. Summary and Conclusions

This paper began by outlining certain generic problems that generally all micro-based studies of the impact of FDI have to face. Firstly, the various UK data sources available differ in terms of how nationally representative they are, and consequently weighting data as part of the modelling approach is important. Since most subsidiaries of MNE's operating in the UK are relatively large, and most datasets (such as FAME and OneSource) are heavily biased towards large firms, failure to weight data can lead to limited comparisons being made between large domestic and foreign owned firms/plants. There is also an issue of how linkages are measured in empirical work and thus how to construct proxy measures of FDI presence leading to spillovers. Since the researcher almost never has data on whether there are actual flows of knowledge, people, goods, or information between firms/plants, it is difficult to directly measure spillovers and nearly all studies therefore cannot sort out the direction of causality between spillovers involving FDI and domestic plans.

Other generic issues are whether it is more appropriate to use aggregate (e.g., industry-level) data or micro (firm/plant) level data. The benefits from using the latter and being able to control for individual characteristics would seem to far outweigh the advantages from using aggregated data. There is also a general issue of how to measure total factor productivity, with those studies that take a two-stage approach (derive TFP from, say, a growth accounting approach and then estimate a second-stage model of the determinants of TFP) suffering from bias because mainly of an omitted variables problem.

The paper then looks at whether FDI plants are 'better', with the evidence suggesting that if the parent country of the MNE is located in the U.S., then the answer is usually 'yes'. Evidence was also presented that suggests that foreign-owned firms/plants are better than non-exporting indigenous firms in the UK, but they are not always better than indigenous firms that export. However, foreign-owned firms that also export are clearly as a sub-group the best in terms of productivity. Lastly, some evidence was presented that suggests that this is not always the case in every region, with foreign-owned manufacturing plants in Northern Ireland tending to have no clear productivity when compared to UK-owned plants operating in that region.

Turning to the direct benefits of FDI, clearly if FDI plants have on average higher productivity then they have an overall beneficial impact through a 'batting-average' effect. In Northern Ireland, where there seems to be no real (labour) productivity advantage, foreign-owned firms actually lowered productivity growth between 1998 and 2006. As to whether there is a transfer of technology from MNE's to newly-acquired plants (through takeovers), leading to a post-acquisition boost to productivity, it was argued that this may in part depend on whether MNE's 'cherry-pick' the best plants to acquire, and whether post-acquisition there are short-run assimilation problems with the newly acquired plants causing TFP to fall. Certain evidence suggests this may be the case, although there are sample selectivity issues that need to be taken account of in this type of analysis.

It was also argued that outward FDI by UK MNE;s might also provide direct benefits to the domestic plants in these organisations, as overseas technology is sourced. This may also provide additional spillover impacts, as studies of the impact of outward FDI tend to show that the productivity benefits to the home country are important.

Turning to spillovers (i.e., the indirect benefits of FDI), it was noted that there are a number of definitional problems since spillovers are usually defined in terms of what can be measured (by linking them to the 'presence' of FDI in industries and regions) rather than what they actually represent. The results from studies measuring intra-industry, inter-industry, and agglomeration spillovers tend to provide mixed and overall unclear answers as to their presence and importance. However, more recent developments in the spillovers literature have began to overcome some of the earlier problems in this area. This includes linking spillovers to absorptive capacity (generally plants with higher capacity are more likely to benefit from FDI presence); taking account of the exporting activities (or lack of) of both domestic and foreign firms (with exporting FDI firms tending to have larger spillover impacts); and taking account of the motivation for FDI (i.e., whether it is technology exploiting or sourcing, with the latter likely to lead to negative – or reverse – spillovers). With regard to identifying and measuring spillovers, the alternative identified is to make

more use of survey-based research. But this has its own limitations, such as the results are hard to generalise (being based on typically very small samples); they require respondents to be able to separate out complex cause-and-effect mechanisms that are linked to productivity; and they typically do not involve the use of 'control' groups that have similar productivity characteristics but are not linked to MNE subsidiaries.

As to the size of productivity spillovers, many studies find these to be rather small (e.g. a 10% increase in FDI raises TFP in domestic plants by about 0.5%), although some studies find higher spillovers associated with different types of FDI (especially when it is export-orientated).

On the issue of whether FDI spillovers are more likely in clusters, the evidence suggests that this happens and therefore that the Assisted Areas of the UK (where clusters are less prevalent) tend to experience much lower, or even negative spillover effects. As to whether FDI locates in (pre-existing) clusters, the evidence that is available in the UK would suggest that this occurs (with most clusters being located in London followed by the South East).

Finally, trade (particularly imports) was considered as a source of spillovers and whether these are larger or smaller than FDI spillovers. Some evidence exists that suggests that trade is a more important channel for R&D spillovers than is FDI.

As to some of the policy implications of this review, certain studies have found that the size of spillovers are either too small (or not present in the assisted regions of the UK) to justify the cost-per-job of the assistance provided from grants that are provided to entice firms into (the assisted areas of) the UK. Driffield (2004), De Porpis (2006) and Haskel et. al. (2004) pay particularly attention to this question. There is also an issue with whether in fact more emphasis should instead be placed on increasing the absorptive capacity of domestic firms/plants, in order to maximum the benefits of any spillovers that are available. Some (e.g. Desmet et. al., 2008) actually propose restricting inward FDI until the economy's absorptive capacity is high enough to gain maximum benefits from spillovers; their model shows that a gradualist approach to inward FDI while absorptive capacity is allowed to build-up can actually lead to a higher overall productivity gain (although perhaps more so in developing economies). Lastly, the type of FDI in terms of its export orientation and motivation (sourcing versus exploitation) needs to be considered when spending scarce resources to attract firms into the UK; this is not to suggest limiting inward FDI but rather to targeting the type of FDI that will receive government assistance.

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SERC is an independent research centre funded by the Economic and Social Research Council (ESRC), Department for Business, Enterprise and Regulatory Reform (BERR), the Department for Communities and Local Government (CLG) and the Welsh Assembly Government.