Who Gains from Whom?

Spillovers, competition and technology sourcing in the foreign-owned sector of UK manufacturing*

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ABSTRACT

There is a growing literature explaining FDI flows in terms of 'technology sourcing', whereby multinational firms invest in certain locations not to exploit their firm-specific assets in the host environment, but to access technology that is generated by host country firms. However, it is far from clear that the international business literature has found significant evidence of such activity beyond a few isolated examples. This paper extends this work by allowing for the possibility of MNEs sourcing technology not only from host country firms, but also from each other. The paper demonstrates that MNEs in the UK do indeed appropriate spillovers both from indigenous firms and from other foreign investors, but that there are also significant competition effects that act to reduce productivity in certain industries. The paper also explores which countries' affiliates gain most from technology sourcing in the UK, and which generate the greatest spillovers within the foreign-owned sector.

Keywords: FDI, technology sourcing, spillovers

JEL classification: O31, F23

*We are grateful for the comments of participants at EARIE 2003, EUNIP 2003 and the NUPI/NIK workshop 'Technology and Foreign Ownership', Oslo, December 2002.

1. Introduction

It is often assumed that foreign direct investment (FDI) brings benefits to host economies through productivity spillovers from multinational enterprises (MNEs). Blomström and Kokko (1998) provide several reasons why such productivity effects may take place. Spillovers may occur directly through backwards and forwards linkages with indigenous firms, through the licensing of a particular technology, through supplier networks or subcontracting arrangements, or indirectly as knowledge becomes public and spillovers are assimilated by the domestic sector. Secondly, labour mobility may generate technology or knowledge spillovers, as employees moving from the foreign-owned to the domestic sector transfer firm-specific knowledge.

There is also the possibility of indirect productivity effects on local firms arising from foreign affiliates increasing the host country's knowledge of and access to specialised intermediate inputs (Rodriguez-Clare, 1996). Barrell and Pain (1997) estimate that around 30% of the productivity growth in UK manufacturing between 1985 and 1995 could be associated to the impact of inward investment.

There is now a substantial body of evidence that positive productivity spillovers do indeed occur[i]. However, this process is neither guaranteed nor automatic, and is also potentially problematic to isolate. First, there is the possibility of a market stealing effect, in which more productive MNEs take market share from less efficient domestic producers, forcing them up the average cost curve and so lowering their productivity (Aitken and Harrison 1999). Secondly, there is the possibility that outward FDI may be undertaken not to exploit the technology of an MNE in a new location, but to source the technology of a host country and use it to advantage either in the foreign affiliate or in the MNE's home economy. Under such circumstances, any productivity spillovers may be very limited, or may run in the reverse way from the conventional model i.e. from domestic to foreign enterprises. This phenomenon has become known in the literature as technology sourcing. Technology sourcing behaviour may be particularly important in the flows of FDI between technologically advanced countries; indeed Van Pottelsberghe de la Potterie and Lichtenberg (2001) suggest that much of the outward FDI among the major industrialised countries is of this sort.[ii]

However, the principle of technology sourcing applies not merely to MNEs benefiting from the presence of indigenous firms, but to MNEs benefiting from each other within a host economy. For example, where there is a significant foreign presence in a given country it is reasonable to expect spillovers to develop between the foreign affiliates as well as between foreign and domestic establishments. This is especially likely where a particular industrial sector is composed principally of multinational affiliates which have chosen – or been encouraged – to enter the host economy specifically because of their superior technology. Under such conditions, local firms may lack the absorptive capacity to benefit from productivity spillovers, and externality effects may be restricted to the foreign sector only.

Despite the wealth of research seeking to determine the extent of productivity spillovers from MNEs to the domestic sector in various countries, much less attention has been paid to the possibility of the reverse effect (technology sourcing FDI), or to the phenomenon of productivity spillovers between MNEs within a given host economy. In this paper we examine these phenomena from a UK perspective. In terms of the scale and scope of inward investment, the UK is unique, attracting FDI from more countries and across more industries than any other host economy.

Specifically, we investigate the extent to which the foreign-owned sector is able to capture productivity spillovers both from indigenous UK owned enterprises and also from other foreign-owned affiliates. Our results indicate that the foreign sector in UK manufacturing derives substantial productivity spillovers from UK-owned firms, but that this effect is restricted to relatively R&D-intensive industries. By contrast, productivity spillovers within the foreign-owned sector are more than offset in aggregate by strong market-stealing effects. This is again largely restricted to knowledge-intensive industries. There are, however, substantial differences across nationality of affiliates in terms of their productivity spillover and competitive effects on other foreign affiliates.

2. FDI, competition and productivity spillovers: a conceptual overview

From the perspective of the firm, the decision to engage in FDI is traditionally seen as deriving from the desire to exploit internationally some competitive or ‘ownership’ advantage. Knowledge-based, firm-specific assets may be hazardous to exploit by contractual means such as licensing, because of the property rights and transaction cost problems inherent in the highly imperfect market for knowledge and technology, thus giving an incentive to engage in FDI (Horstmann and Markusen 1996). This form of investment can be described as technology exploiting FDI, and is the form of FDI generally associated with positive productivity spillovers from the foreign sector to the domestic sector.

However, there may be other important motives for FDI. Fosfuri and Motta (1999) and Siotis (1999) present models of the FDI decision which embody the possibility of technology sourcing. They are able to show that a technological laggard may choose to enter a foreign market by FDI even where this involves (fixed) set-up costs and where the transport costs of exports are zero. This is because there are positive spillover effects associated with locational proximity to a technological leader in the foreign country. Assimilation of the acquired technology then decreases the production costs of the investing firm both in its foreign subsidiary operations and in its home production base. Where the beneficial technology spillover effect is sufficiently strong, Fosfuri and Motta show that it may even pay the laggard firm to run its foreign subsidiary at a loss to incorporate the benefits of advanced technology in all the markets in which it operates.

Driffield and Love (2003) present a test of the necessary condition for technology sourcing based on the existence of 'reverse spillovers', that is externalities generated by domestic firms and appropriated by the foreign sector, and show that such spillovers do indeed occur in the UK. However, there is no theoretical reason why the source of such spillovers has to be confined to the domestic sector: the technological leader in any given country or sector could be an existing foreign affiliate, generating the possibility of MNEs learning from each other in a third country. This possibility is consistent with the empirical evidence on the increasing internationalisation of R&D (Cantwell, 1995), and there is now strong evidence that technology sourcing is an important determinant of the international location of R&D by multinationals (Niosi, 1999; Pearce, 1999; Serapio and Dalton, 1999). This frequently involves the establishment by MNEs of 'listening posts' around the world in areas of known technological expertise (Gassman and Von Zedtwitz , 1999). For these reasons productivity spillovers might be expected to occur within the foreign sector of an economy, as well as between the foreign and domestic sectors. Indeed, there is evidence from this literature that, because of the international diffusion of R&D activity, it is sometimes easier for an MNE to source technology from the overseas affiliate of a rival than from the rival's home-based plants.

In seeking to identify spillovers, Aitken and Harrison (1999) point to the possibility 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[iii]. As with technology sourcing, it is possible that there may be a market-stealing effect occurring *within* the foreign-owned sector, which may offset any productivity spillovers occurring between foreign affiliates in a given host economy. It is not difficult to imagine these conditions in a UK context, where MNEs entering the country are more likely to compete with each other than with indigenous firms, especially in industries which are dominated by multinationals. Obvious examples would include the car industry, the electronics industry in Scotland and the white goods sector in South Wales. Indeed, there is recent evidence that inward FDI into the UK does increase competition and reduce profitability overall (Driffield 2001a), an effect which is unlikely to be solely at the expense of the UK sector.

Conceptually, therefore, a taxonomy of possible net productivity effects of inward FDI can be established, depending on the motivation for FDI (technology exploiting or technology sourcing) and on the possibility of a market-stealing (i.e. competition) effect. From the perspective of the domestic sector, anticipated spillover effects from FDI will be unambiguously (net) positive only if the motivation for FDI is technology exploiting (so that there is some technological advantage which may spill over to the domestic sector) and there is no market-stealing effect by incoming MNEs. Where there is such competition, technology-exploiting FDI may have a positive or negative effect on domestic productivity, depending on whether the spillover or competition effects predominate. Where the motivation for inward FDI is technology sourcing, positive spillovers are unlikely as the incoming multinational is likely to be a technological laggard with little to offer the domestic economy. If there is no market-stealing competition effect the likely outcome is no spillover effect, with a probable negative effect on domestic productivity if technology sourcing FDI is accompanied by competition through market stealing[iv].

From the perspective of the foreign sector, anticipated spillover effects from other foreign affiliates will follow the pattern outlined above. However, the picture for the foreign sector is further complicated by the possibility of spillovers from the domestic sector, as theorised by Fosfuri and Motta (1999) and shown empirically by Driffield and Love (2003).

3. Determining the scale of productivity spillovers.

The method for identifying technological externalities adopted here follows the seminal paper by Griliches (1992), who postulates an augmented production function including both internal and external factors of production. The presence of such external influences on the firm is the consequence of externalities in production, due to formal or informal linkages between firms.

$$\ln Q_{it} = a + \beta_1 \ln(K_{it}) + \beta_2 \ln(L_{it}) + \sum_{p=1}^{r} \mu_p X_{ikt} + v_{it} \qquad (1)$$

Where X is the vector of externalities, which is linked (usually positively) to total factor productivity. It is assumed that there may be individual and time effects i.e. $v_{it} = \alpha_i + \nu_t + u_{it}$, where u_{it} are the random errors, assumed to be iid (0, σ_u^2).[v]

This framework has been used to test for spillovers from FDI in the conventional sense, that is the extent to which capital investment by foreign owned firms is linked to total factor productivity in the domestic sector. For recent examples of this literature and methodology, see Haskel et al (2001), Harris (2002), Harris and Robinson (2002), Driffield (2001b) and the earlier literature summarized in Görg and Strobl (2001).

In addition, a further factor in studies of productivity growth and externalities is the importance of learning by doing and the cumulative effects of continuous production. Islam (1995) shows that the appropriate specification within an econometric framework is to relate current total factor productivity to previous levels of output. By definition, this captures the importance of past levels of inputs in the production process. Therefore a dynamic specification is employed in which accumulated experience is proxied by a lagged dependent variable, as in (2). For further discussion of the econometric specification of this problem, see Lee et al (1998) and Pesaran and Smith (1995).

Thus, to encompass learning by doing effects, the specification becomes:

$$\ln Q_{ijt} = a + \gamma \ln Q_{ijt-1} + \beta_1 \ln(K_{ijt}) + \beta_2 \ln(L_{ijt}) + \sum_{p=1}^{r} \mu_p X_{ikt} + v_{ijt} \qquad k \neq j \qquad (2)$$

with the data stratified by industry (i), country of ownership (j) and time (t).

The econometric specification of externalities

As Oulton (1997) and Driffield (2001b) outline, many studies of externalities suffer from specification error. For example, Oulton (1996) and Basu and Fernald (1995) suggest that if the vector of externalities in a specification such as equation (2) contains output variables, then a change in aggregate demand, impacting simultaneously on internal and external output, may generate spurious 'evidence' of externalities or spillovers where none exist. This arises as a result of the error term in (2) being related to aggregate output growth. The problem of spurious externality effects can largely be alleviated by a more precise specification of the externality term.

On both theoretical and econometric grounds, the vector of spillovers used here is lagged external investment i.e. investment external to the group of firms under investigation. The theoretical justification for this, derived from the theory of the firm, is that technological advance (or technology new to a particular location), or the international transfer of firm-specific assets, is embodied in new capital investment rather than in output, employment, or local R&D expenditure[vi].

Econometrically, the use of lagged external investment results in a tightly defined source of potential spillovers, so it is unlikely that the 'spillover' variable will be related to the error term in (2)[vii]. One possible test for the appropriateness of our specification is to replace the investment term with the comparable value for contemporaneous output. If this produces no significant result, then one can be confident that any results generated using lagged investment are not the result of spurious correlation. This is discussed at length in Driffield (2001b) and the appropriate test is carried out in the econometric analysis below[viii].

4. Data and Method of Estimation

The data set employed here was obtained from the UK Office for National Statistics (ONS). This provides annual data from 1984 to 1997 on input and output flows (including sales and value added), capital investment and employment by industrial sector and country of ownership for each of 31 manufacturing industries.[ix] In total, the database includes 24 countries of ownership including the UK, but in practice the analysis is restricted to 22 countries of ownership, plus the UK, accounting for over 99% of all activity in these industries. This provides some 713 observations per year: while not all countries are represented in each sector in each year, the presence of a certain source country in a given industry is relatively consistent over the time period.

Table 1 illustrates the breakdown of foreign investment by country of ownership in the UK. This conforms to the relatively well understood pattern that over the time period some 23% of capital investment in UK manufacturing was carried out by foreign owned firms, the largest single investor being the USA (13%) and the rest of Europe totalling 5.4%. Japan accounts for just under 2% of total investment. The pattern of overall investment is reflected in the number of industries which have a presence: US investment is spread across several industries, while most other countries' investment is concentrated in a few industries, as has been documented elsewhere.[x]

The use of industry level data does, of course, require us to consider the possibility of spurious results when estimating externality effects: it is conceivable, for example, that FDI is simply attracted to industries with the potential for high growth. However, it is possible to allow for this by instrumenting the FDI variables with lags and by including full sets of industry and time dummies in the models. Görg and Strobl (2001) argue that the potential aggregation bias from industry level data is minimal in practice, and the alternative of using firm or plant-level data has its own drawbacks. Estimating growth equations with firm-level panel data can lead to specification problems as well as the invalidity of instruments for capital and employment at the firm level, if capital stock data are available at all. This is a problem first explored by Griliches and Mairesse (1995). As a result, the firm level analysis of externality effects tends to rely on the rather less reliable two-step approach to explaining variations in total factor productivity growth.

As is well understood, the GMM estimator suggested by Blundell and Bond (1998) can be used to estimate (2), which generates heteroscedastic-consistent estimates. This involves taking first differences in order to generate a transformed difference equation, then estimating this simultaneously with the levels equation. All explanatory variables are instrumented with all possible lagged values, as discussed in Arellano and Bond (1988, 1991). There is a concern that with the estimation of what is essentially a 'growth' model, the estimate of the coefficient on the lagged dependent variable has an upward bias if the panel data exhibits significant heterogeneity (Pesaran and Smith, 1995). There is no definitive test for this, but a reasonable test with these data is to allow for slope dummies in the lagged dependent variable, allowing γ to vary across industries or across country of ownership. Standard specification tests reject the inclusion of such variables, suggesting that heterogeneity is not a problem in these data.

The econometric estimation proceeds in three parts. We first determine whether there is evidence of any investment externalities in UK manufacturing industry. Having confirmed the existence of investment externalities in productivity growth, we then distinguish between differential effects of investment by foreign and domestic firms, and subsequently investigate the investment externalities accruing to the foreign sector in UK manufacturing. The second part of the empirical analysis therefore investigates whether the foreign sector derives productivity spillovers from investment by other firms in the UK, whether these derive mainly from the domestic (UK-owned) sector or from other foreign-owned establishments, and the extent to which any effect is restricted to R&D-intensive industries. The third part examines the extent to which the foreign-owned sector benefits from spillover effects arising from the FDI activities of selected other foreign countries' affiliates.

5. Results of Econometric Analysis

5.1 Overall investment externalities

The initial estimation is designed to detect the existence of intra-industry investment externalities between establishments of different nationalities. The dependent variable is therefore $\ln Q_{ijt}$, the value added of establishments owned by country j in sector i in a given year expressed in real terms (1990 prices). The domestic (i.e. UK-owned) sector is simply one element of the vector j in this case. The 'internal' independent variables are as follows: K is a measure of capital stock; ML is employment of operatives; NL is employment of non-operatives (both expressed as

FTEs); while X is the external investment elsewhere in the industry (k≠j) and captures the externality term. As is common with data of this sort, information on capital stock is either unavailable or extremely unreliable. The sum of net investment over the previous four years is therefore used as a proxy, with a standard depreciation rate of 10%. The externality term in is based on external capital stock (i.e. investment in the industry by firms of all other nationalities), the exact definition and measurement of which varies with the sample being used for the estimation. This is calculated for the various sub-samples in the same manner as internal capital, i.e. perpetual inventory in real terms with depreciation.

Because of marked changes in industrial classification in 1992, the estimation is carried out separately for the periods 1984-92 and 1993-97. This also explains the single measure of employment (L) used in the latter estimation; from 1993 ONS does not report data separately for the employment of operatives and non-operatives.

The results of estimating equation (2) are given in Table 2. The estimations produce a well-behaved production function, with clear evidence of investment externalities generally in UK manufacturing (positive and significant coefficients on X_{it-1} for both time periods). There is of course the possibility that certain industries are dominating and driving these results. There are numerous ways of extending the analysis to test for this. One possibility is to apply weights to the data, in order to prevent small sector / country combinations having an undue effect. The results presented here are not sensitive to the application of weights[xi], but this at best is an econometric rather than theoretical solution. Our attention therefore turns to the foreign sector, omitting the UK owned firms, and to individual country effects in turn. While standard Chow-type tests confirm that uniform parameters can be applied to the 'internal' variables, both across country of ownership and sector, the individual country externality effects are more informative.

5.2 Investment externalities accruing to the foreign sector

The analysis is now restricted to the foreign sector, and we investigate whether the foreign sector benefits from spillovers arising from investment both by indigenous UK firms (the domestic sector) and from other foreign-owned firms operating with the UK (the other-foreign sector). Equation 2 is therefore re-estimated for the foreign sector only, with the investment externality measure now split between domestic investment (UKI_{it-1}) and other-foreign investment (FDI_{it-1}). Results are shown in Table 3. For both time periods the results are consistent and striking. There is strong evidence of positive ‘reverse spillovers’ i.e. externalities accruing to the foreign sector from investment by the domestic sector. By contrast, other-foreign investment gives rise to negative productivity effects among the foreign sector.

The former result gives support for ‘technology sourcing’ FDI, in which foreign firms enter the UK in order to access the technology of indigenous firms rather than to exploit their own superior technology in the UK. Other empirical evidence supports the possibility of this form of FDI. For example, Cantwell (1999) shows that the pattern of US investment in the UK changed during the late 1980s and 1990s, away from industries in which US multinationals are technologically strong towards those industries in which the UK has significant technological expertise. Cantwell sees this as consistent with a technology sourcing approach, and with the internationalisation of the search for technology outlined earlier. More generally, in a study of FDI flows between major industrialised countries over twenty years, van Pottelsberghe de la Potterie and Lichtenberg (2001) find that outward FDI makes a positive contribution to domestic total factor productivity. The presumed mechanism for this is that spillover effects are generated by accessing the foreign R&D capital stock in target countries; by contrast, inward FDI has no such effect. They therefore conclude that FDI flows are predominantly technology sourcing in nature, and that inward FDI in particular represents a 'Trojan horse', motivated principally by the desire to take advantage of the technological base of host countries.

The negative other-foreign externality suggests that there is a substantial market-stealing effect occurring between foreign manufacturing establishments in the UK. Either there are no spillovers between foreign establishments, or any such effect is more than offset by a strong competition effect (Aitken and Harrison 1999). On balance, foreign firms entering the UK gain from indigenous investment, but compete with other foreign firms.[xii]

A prori it is likely that spillover effects will be particularly strong in knowledge-intensive industries. These are the industries in which technology transfer via FDI is most likely to occur and consequently from within which there is the greatest technological expertise to be gained through spillovers. We therefore perform the estimation of equation (2) separately for R&D intensive and non-R&D intensive industries (Table 4). Following the usual convention in the industrial organization literature, an R&D intensive industry is defined as one where R&D expenditure exceeds 1% of value added in a given year. Data on R&D were provided by the ONS.

The results for the R&D intensive industries mirror closely those for the foreign-owned sector overall. By contrast, there is no evidence of positive externalities in the non-R&D intensive industries, but some indication of a competition effect between foreign affiliates in the UK. These findings provide further support for the view that at least some FDI in UK manufacturing is motivated by technology sourcing, and that this sourcing is targeted towards research-intensive indigenous UK establishments rather than foreign subsidiaries operating in the UK. However, the principal source of competition for foreign affiliates in both high and low R&D industries appears to be other foreign affiliates, not UK establishments.

5.3 Individual country effects

We know from the estimates above that, within the foreign-owned sector overall, competition effects offset productivity enhancing effects. This does not mean that no productivity spillovers exist, however, merely that they may be masked by more substantial market stealing effects. It is possible, further, that the nature and strength of the competition and productivity effects vary within the foreign sector, so that affiliates from different countries generate different spillovers effects within the foreign sector of UK manufacturing. The final part of the empirical estimation therefore examines whether FDI from specific countries within the UK generates spillovers that other foreign affiliates can appropriate.

This is done by re-estimating equation (2), but allowing the spillover variable to relate to a specific country i.e. the variable X_{it} comprises the lagged investment of affiliates from a given country. The dataset permits this estimation to be performed for nine major investing countries. There is a potential source of spurious correlation here, in that any individual country effects may be caused by heterogeneity in the data or by individual industry level effects. In order to allow for this a full set of time dummies and industry dummies were included in the analysis. There is no evidence that the results reported here are sensitive to the inclusion of such dummies, which is reassuring given that several countries (Japan, Sweden and Ireland for example) have their investment in the UK concentrated in a few industries.

Results for both time periods are summarised in Tables 5a and 5b respectively, which show the coefficient value and level of significance for the externality parameter[xiii]. The country specific-effects reveal that there are indeed substantial variations, both among countries and between the high and low R&D industries. Although competition effects predominate overall in the foreign-owned sector (see Table 3), positive productivity externalities are evident from investment by affiliates originating from the Netherlands, Sweden and Switzerland for the period 1984-92. In addition, investment from Germany, Canada and the United States also generates significant positive effects, but only for R&D intensive industries. Only Japanese affiliates have a negative productivity effect overall on other foreign firms in the UK, while French firms generate a negative effect for high R&D industries. In general, efficiency effects offset competition effects (i.e. the externality coefficient is positive) in the knowledge intensive (high R&D) industries, with negative or no spillover effects in the low R&D industries. The exceptions to this general pattern are Sweden and Switzerland, which record significant positive effects in both high and low R&D industries.

For the later time period (Table 5b) the pattern is broadly similar. The major difference relates to France, where the negative effect in high-R&D industries disappears, and the overall externality effect becomes weakly positive. The negative effect for Japan is now restricted to the low R&D industries.

Overall, foreign affiliates operating in knowledge-intensive industries in the UK derive positive productivity effects from contact with other foreign affiliates, except those from France in the earlier time period. In less R&D intensive industries, where the scope for knowledge-based intangible transfers is more limited, competition effects offset or outweigh productivity spillovers, with the effect particularly noticeable for affiliates originating from Japan. Swedish and Swiss affiliates are a notable exception to this pattern, apparently generating significantly positive spillovers even in low R&D industries.

The major investing country in the UK has long been the United States. A further insight into the nature of competitive and productivity-enhancing effects within the foreign-owned sector can be gained by the estimation of (2) for a subset of industries, omitting the US-owned firms. The coefficients on X_{it} can then be interpreted as an estimate of whether investment by non-US firms in the UK generates spillovers to other non-US firms. Tables 6a and 6b present these estimated coefficients, and reproduce the coefficient estimates from Tables 5a and 5b for comparison. The results of a t-test of equality in the spillover elasticities is also shown, indicating whether the estimates of the spillover effects of FDI among the foreign-owned sector in the UK are significantly different when US firms are included in the analysis.

The results indicate that the strong competition effects generated by R&D intensive French firms impact largely on American affiliates in the UK. Indeed, in the absence of US firms the externality effect of French firms in the R&D intensive industries becomes strongly positive in both periods, in line with that of most countries. By contrast, Japanese R&D intensive firms show precisely the reverse pattern. When US firms are removed from the analysis the externality effects in both periods become sharply negative, indicating that European affiliates in the UK bear the brunt of Japanese knowledge-intensive competition. However, Japanese low R&D

competition is aimed at both American and European affiliates (the externality is consistently negative), with some suggestion of increased Japanese competition with European rivals during the latter period. This suggests that Japanese affiliates operating in industries which are not knowledge intensive have widened their ability to take market share from other (mainly European) MNE affiliates based in the UK.

The comparison of with-US and without-US externality effects also sheds some light on which countries' affiliates contribute most to the productivity of US firms operating in the UK. Everyone in the foreign sector appears to benefit from the presence of Swedish and Swiss affiliates in the knowledge-intensive industries, but when US affiliates are removed from the analysis much stronger competition effects are evident in the low R&D industries, implying that American affiliates are the ones which principally benefit from productivity spillovers arising from Swedish and Swiss firms operating in the less knowledge-intensive industries in the UK.

Our initial results suggested that foreign firms entering the UK generally gain from indigenous investment, but compete with other foreign firms. We can now refine the latter part of that conclusion, not only in terms of different industries and the importance of R&D intensity, but also in terms of the country specific effects. The dominance of the competition effect is restricted largely (but not exclusively) to low R&D industries, with 'new' foreign investment from Japan taking significant market share from European affiliates in the UK. This evidence of significant crowding out effects within the UK as a result of new FDI is consistent with results reported elsewhere (Buffie,1993; Driffield,1999). In the knowledge intensive industries, foreign affiliates generally exhibit productivity-enhancing effects from the affiliates of other investing nations, especially in the chemicals, electrical engineering and instrument engineering industries which account for the majority of the high R&D investment in the sample. The results of Tables 6a and 6b suggest that the greatest positive spillover effects seem to involve European firms appropriating spillovers from each other in industries where their productivity is very similar, or where US firms source technology from a very select group of (mainly Swedish and Swiss) firms in particular industries. Perhaps the most interesting result concerns the spillover effects generated by Canadian FDI. Canadian firms in R&D intensive sectors generate spillovers, but these effects are greater when the impact on US firms is included. It seems unlikely that US firms would source technology from Canadian firms by entering the UK, so the result is more suggestive of general agglomeration economies, with firms from North America and the more technology intensive countries of Europe locating in certain countries to access a general stock of knowledge, rather than targeting certain countries per se.

6. Conclusions

This paper has concentrated on the search for productivity and competition effects within the foreign-owned sector in UK manufacturing, and between the foreign and domestic sectors. Our results indicate that the foreign sector in UK manufacturing derives substantial productivity spillovers from UK-owned firms, but that this effect is restricted to relatively knowledge intensive industries. Productivity spillovers within the foreign-owned sector are also largely restricted to knowledge-intensive industries, but in aggregate are more than offset by market stealing effects. However, the nature of the interaction between productivity and competition effects is complex, and there appears to be significant variation across countries of ownership, and across industries. The scope for technology sourcing between MNE affiliates in the UK is clearly significant, as is the scope for competition. Overall, the results suggest that the firms experiencing the competition effects most strongly are other European firms, largely at the hands of Japanese firms. This offers an interesting perspective on the tariff-jumping rationale for FDI, to the extent that Japanese and US firms entered the UK over this period in order to access the European single market. Those most likely to lose out as a result of this are the European (including the UK) firms. This result is illustrated by not only the individual country effects, but also the overall effects reported in Tables 2 and 3, given that the majority of FDI is from the US.

One obvious interpretation of this research overall is that technology sourcing by foreign affiliates in the UK is not restricted to UK establishments, but also occurs within the foreign-owned sector. While this is doubtless true, our results are also consistent with a broader scenario, outlined earlier with respect to Canadian affiliates. This is an agglomeration effect, where a given (knowledge intensive) sector has a high degree of foreign ownership and large quantities of inward FDI. Under such conditions, the opportunity for both rent and pure knowledge spillovers to develop might be very great, and regardless of whether inward FDI was consciously motivated by technology sourcing considerations, positive productivity externalities are likely to develop among foreign affiliates. It is not difficult to imagine this being the case in the pharmaceuticals, chemicals and electronic industries in the UK, all of which have a major foreign presence. Although these foreign affiliates may well compete with each other, the UK provides such a small part of their total market that any competition effect within Britain is more than swamped by the efficiency-enhancing effects of being in relatively close proximity to other highly research-active enterprises. By contrast, the strong market-stealing effect exhibited by Japanese producers mainly in less knowledge-intensive industries is a feature of production plants producing mainly for the domestic market, which is the case for many of the Japanese white goods producers located in Wales, and to some extent also true of Japanese-owned car plants in the UK.

Our results may also have policy implications. National and regional governments have a long history of offering financial and other inducements to multinational enterprises in order to encourage the establishment of local production facilities. While this is done partly in order to benefit from expected direct and indirect employment increases, there is a recognition among many agencies that the benefits of FDI may go far beyond those of employment. From a welfare perspective, encouraging inward investment may be justified if the social returns to FDI exceed the private returns. In practice, such an effect is usually regarded as being most likely in terms of local firms deriving some productivity spillovers from gaining access to the firm-specific knowledge that accompanies inward FDI. While such spillover effects may arise, our results indicate that this is not a one-way process: foreign affiliates clearly benefit from the technology of indigenous UK firms, as well as that of other foreign affiliates. This suggests that, in order to see the full costs and benefits of inward FDI, policy-makers might benefit from research which further explores the links between the motivation for FDI and its productivity and competition effects, not just between the domestic and foreign sectors, but also within the foreign-owned sector.

Table 1: Foreign investment by country of ownership over the period.

Country	Number of industries (max=31)	Total investment 1984-1997 £ million
Australia	4	626794.35
Belgium	1	24212.31
Canada	10	1667601.67
Denmark	3	236713.81
Finland	2	545932.07
France	14	2472018.66
Germany	15	3934459.92
Hong Kong	1	0.00
Israel	1	8604.24
Italy	1	96974.52
Japan	8	3990882.50
Liechtenstein*	12	142942.28
Luxembourg	1	43413.26
Malaysia	1	1688.94
Netherlands	11	1289473.39
Norway	2	266918.05
Republic of Ireland	10	438327.67
South Africa	1	12014.06
Sweden	8	847707.35
Switzerland	12	2401912.45
Taiwan	1	10183.00
United Kingdom	29	167569474.74
United States	26	28755106.52

* Investment from Liechtenstein was excluded from the empirical analysis on the grounds that MNEs of many nationalities use Liechstenstein registration as a flag of convenience.

Table 2. Estimation of equation 2: all nationalities

1984-1992				1993-1997			
Parameter	Estimate	t-stat	P-value	Parameter	Estimate	t-stat	P-value
Q_{it-1}	0.003	0.24	[.810]	Q_{it-1}	0.477	3.43**	[.001]
ML_{it}	0.411	3.70**	[.000]	L_{it}	0.652	4.76**	[.000]
NL_{it}	0.408	3.24**	[.000]				
K_{it}	0.079	3.78*	[.000]	K_{it}	0.154	2.40**	[.017]
X_{it-1}	0.104	3.38**	[.000]	X_{it-1}	0.116	3.60**	[.000]
time	0.067	3.23**	[.000]	time	0.131	1.76*	[.079]
Specification $\chi^2(5)$				Specification $\chi^2(4)$			
Sargan - p value				Sargan - p value			
serial correlation AR(2) ~ $\chi^2(1)$				serial correlation AR(2) ~ $\chi^2(1)$			
N (9 years)		1538		N (5 years)		835	

Table 3. Estimation of equation 2: Foreign sector only

1984-1992				1993-1997			
Parameter	Estimate	t-stat	P-value	Parameter	Estimate	t-stat	P-value
Q_{it-1}	0.032	1.06	[.290]	Q_{it-1}	0.060	1.44	[.152]
ML_{it}	0.407	3.67**	[.000]	L_{it}	0.684	8.14**	[.000]
NL_{it}	0.527	3.13**	[.000]				
K_{it}	0.111	3.60**	[.029]	K_{it}	0.276	6.69**	[.000]
UKI_{it-1}	0.069	2.33**	[.001]	UKI_{it-1}	0.031	3.68**	[.000]
FDI_{it-1}	-0.132	-4.94**	[.000]	FDI_{it-1}	-0.068	-6.69**	[.000]
time	0.061	3.12**	[.002]	time	0.074	2.00**	[.046]
Specification $\chi^2(3)$				Specification $\chi^2(3)$			
Sargan - p value				Sargan - p value			
serial correlation AR(2) ~ $\chi^2(1)$				serial correlation AR(2) ~ $\chi^2(1)$			
N (9 years)		1415		N (5 years)		798	

Table 4. Estimation of equation 2: Foreign sector only (low and high R&D intensity)

Low R&D industries

1984-1992				1993-1997			
Parameter	Estimate	t-stat	P-value	Parameter	Estimate	t-stat	P-value
Q_{it-1}	0.005	2.52	[.012]	Q_{it-1}	0.005	2.89**	[.004]
ML_{it}	0.516	7.42**	[.000]	L_{it}	0.585	6.59**	[.000]
NL_{it}	0.721	9.77**	[.000]				
K_{it}	0.131	7.48**	[.009]	K_{it}	0.133	3.87**	[.000]
UKI_{it-1}	0.060	1.10	[.272]	UKI_{it-1}	0.033	1.65	[.100]
FDI_{it-1}	-0.063	-11.00**	[.000]	FDI_{it-1}	-0.035	-1.59	[.113]
time	0.029	3.31**	[.001]	Time	0.025	3.09**	[.002]
Specification $\chi^2(5)$				Specification $\chi^2(4)$			
Sargan – p value				Sargan - p value			
serial correlation AR(2) ~ $\chi^2(1)$				serial correlation AR(2) ~ $\chi^2(1)$			
N (9 years)		952		N (5 years)		391	

High R&D industries:

1984-1992				1993-1997			
Parameter	Estimate	t-stat	P-value	Parameter	Estimate	t-stat	P-value
Q_{it-1}	0.011	5.62*	[.000]	Q_{it-1}	0.014	1.48	[.142]
ML_{it}	0.334	3.14**	[.000]	L_{it}	0.811	15.90**	[.000]
NL_{it}	0.499	7.56**	[.000]				
K_{it}	0.339	9.35**	[.000]	K_{it}	0.244	6.27**	[.000]
UKI_{it-1}	0.045	7.56**	[.000]	UKI_{it-1}	0.100	5.05**	[.000]
FDI_{it-1}	-0.045	-6.68**	[.000]	FDI_{it-1}	-0.117	-3.18**	[.002]
Time	0.020	0.28	[.773]	Time	0.080	0.38	[.709]
Specification $\chi^2(5)$				Specification $\chi^2(4)$			
Sargan - p value				Sargan - p value			
serial correlation AR(2) ~ $\chi^2(1)$				serial correlation AR(2) ~ $\chi^2(1)$			
N (9 years)		463		N (5 years)		407	

Table 5a. Estimates of FDI_{it-1}: Country-specific effects 1984-92

Country	Full sample	High R&D Industries	Low R&D Industries
USA	0.011 (1.89) i=16	0.0014 (3.82) i= 9	-0.0013 (-1.20) i=7
France	0.0016 (0.63) i=13	-0.0096 (-3.85) i=6	0.0018 (1.33) i=7
Germany	0.002 (1.18) i=13	0.0089 (6.75) i=6	0.001 (0.57) i=7
Japan	-0.002 (-2.31) i=8	0.002 (1.54) i=6	-0.004 (-2.02) i=2
Netherlands	0.130 (3.04) i=11	0.142 (2.56) i=6	0.025 (1.33) i=5
Sweden	0.027 (2.80) i=7	0.024 (2.62) i=2	0.0038 (2.90) i=5
Switzerland	0.0018 (3.76) i=10	0.002 (2.04) i=4	0.029 (2.21) i=6
Republic of Ireland	0.0006 (0.67) i= 10	0.0065 (1.07) (i=4)	-0.00072 (-1.13) i=6
Canada	0.013 (1.22) i=8	0.007 (2.98) i=5	-0.001 (-1.12) i=3

t- statistics in brackets.
i refers to the number of industries with an ownership presence from that country for at least 4 consecutive years.

Table 5b. Estimates of FDI_{it-1}: Country-specific effects 1993-1997.

Country	Full sample	High R&D Industries	Low R&D Industries
USA	0.029 (1.22) i=20	0.057 (2.73) i=9	0.058 (1.38) i=11
France	0.094 (1.71) i=8	0.039 (1.86) i=5	0.035 (1.23) i=3
Germany	0.062 (1.90) i=8	0.060 (2.30) i=5	0.020 (0.72) i=3
Japan	0.006 (0.34) i=3	0.084 (1.88) i=2	-0.060 (-3.15) i=1
Netherlands	0.026 (0.784) i=8	0.060 (2.15) i=3	0.002 (0.23) i=5
Sweden	0.136 (6.29) i=3	0.109 (3.73) i=2	0.030 (1.77) i=1
Switzerland	0.059 (2.43) i=7	0.093 (4.12) i=4	0.060 (1.90) i=3
Republic of Ireland	0.0086 (1.18) i=7	0.015 (1.22) i=2	-0.017 (-0.81) i=5
Canada	0.040 (1.35) i=8	0.087 (2.05) i=5	-0.032 (1.05) i=3

t-statistics in brackets.
i refers to the number of industries with an ownership presence from that country for at least 4 consecutive years.

Table 6a: Estimates of FDI_{it-1}: Country-specific effects 1984-92 *(excluding US)*

Country	Full sample	High R&D Industries	Low R&D Industries
France	0.0016 (0.63) *-0.0003 (-0.42)*	-0.0096 (-3.85) *0.0077 (3.99)****	0.0018 (1.33) *-0.0007 (-1.60)**
Germany	0.002 (1.18) *0.0017 (1.69)*	0.0089 (6.75) *0.0076 (2.26)*	0.001 (0.57) *0.001 (2.04)*
Japan	-0.002 (-2.31) *-0.0171 (-1.91)**	0.002 (1.54) *-0.0027 (-2.73)****	-0.004 (-2.02) *-0.0011 (-0.72)*
Netherlands	0.130 (3.04) *0.0602 (4.03)*	0.142 (2.56) *0.0813 (4.25)*	0.025 (1.33) *0.0028 (2.39)*
Sweden	0.027 (2.80) *0.0043 (4.09)***	0.024 (2.62) *0.0020 (2.28)***	0.0038 (2.90) *0.0012 (1.56)*
Switzerland	0.0018 (3.76) *0.0015 (1.73)*	0.002 (2.04) *0.0072 (2.53)**	0.029 (2.21) *0.0068 (1.17)*
Republic of Ireland	0.0006 (0.67) *0.00009 (1.26)*	0.0065 (1.07) *0.0097 (2.22)*	-0.00072 (-1.13) *-0.0014 (-2.19)*
Canada	0.013 (1.22) *0.0004 (0.37)*	0.007 (2.98) *0.0014 (2.46)****	-0.001 (-1.12) *-0.0012 (-1.13)*

t- statistics in brackets refer to the estimated coefficients.

Asterisks refer to a t-test of equality of mean estimated spillover elasticities (with and without US). Significant at *10%, **5%, ***1% on a two-tailed test.

Table 6b. Estimates of FDI_{it-1}: Country-specific effects 1993-1997 *(excluding US)*

Country	Full sample	High R&D Industries	Low R&D Industries
France	0.094 (1.71) *0.035 (2.14)**	0.039 (1.86) *0.052 (2.61)*	0.035 (1.23) *0.017 (0.57)*
Germany	0.062 (1.90) *0.045 (2.22)**	0.060 (2.30) *0.075 (2.74)***	0.020 (0.72) *0.010 (0.37)*
Japan	0.006 (0.34) *-0.009 (-0.58)*	0.084 (1.88) *-0.107 (-2.66)***	-0.060 (-3.15) *-0.021 (-3.11)****
Netherlands	0.026 (0.78) *0.017 (3.60)*	0.060 (2.15) *0.015 (1.33)*	0.002 (0.23) *0.045 (1.53)*
Sweden	0.136 (6.29) *0.014 (0.56)****	0.109 (3.73) *0.181 (3.31)****	0.030 (1.77) *-0.055 (-2.86)**
Switzerland	0.059 (2.43) *0.095 (4.93)***	0.093 (4.12) *0.016 (2.84)****	0.060 (1.90) *-0.100 (-4.84)*
Republic of Ireland	0.0086 (1.18) *0.022 (0.97)*	0.015 (1.12) *0.047 (1.37)*	-0.017 (-0.81) *0.027 (1.47)*
Canada	0.040 (1.35) *0.021 (1.27)*	0.087 (2.05) *0.053 (2.15)*	-0.032 (-1.05) *-0.034 (-1.08)*

t- statistics in brackets refer to the estimated coefficients.

Asterisks refer to a t-test of equality of mean estimated spillover elasticities (with and without US). Significant at *10%, **5%, ***1% on a two-tailed test.

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[i] See Blomström and Kokko (1998) for a review of the evidence. However, Görg and Strobl (2001) demonstrate that this may be sensitive to the measure of foreign involvement.

[ii] However, Love (2003) finds little evidence of technology sourcing among inward or outward US FDI over the period 1981-95.

[iii] 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.

[iv] Technology sourcing with market stealing is an unlikely combination in reality, because the technological laggard is in a poor position to compete with local or other foreign firms. For this reason Sembenelli and Siotis (2002) conclude that technology sourcing is likely to leave competitive conditions unchanged. They also point out that competition and spillover effects might not only go in opposite directions but have different dynamics, the former rapid and short-run and the latter occurring more slowly and lasting longer.

[v] This is the standard 'fixed effects' model, which is well understood, and is explained for example in Baltagi (1995). This allows for an industry specific component, and a time specific component. The econometric treatment of this is discussed in the text.

[vi] This argument is the basis for the importance of inward capital investment (rather than employment or output) on a host economy, see for example Dunning (1958), Hood and Young (1979). Blomström (1986) stresses that it is ownership of *assets* that counts in FDI, not employment, while Hejazi and Safarian (1999) point out that employment or output measures may understate the level of FDI, because of the greater capital intensity of MNEs compared to indigenous enterprises.

[vii] See Oulton (1996) for a full discussion of this. Empirically this can be tested for using standard heteroskedasticity or specification tests.

[viii] We formally test for this by substituting contemporaneous domestic output for lagged capital growth in estimating equation 2. This specification is rejected in all the results presented below, using standard specification tests.

[ix] These data are similar therefore to the type of information that is provided in the UK Annual Business Inquiry, formerly the Report on the Census Of Production, published annually by the UK Office for National Statistics.

[x] For an in-depth description of the geographical and industrial distribution of FDI into the UK see Pain (2001).

[xi] Weights based both on industry size and the relative importance of country of ownership were employed, but to little effect.

[xii] Clearly this is a *net* effect. It is conceivable that foreign firms do appropriate spillovers from each other as much as they do from UK firms, but that they compete only (or largely) with each other in such a way that the net externality effect is negative. This is investigated further below.

[xiii] Details of the full estimation of equation 2 for each country are available from the authors.