THE LOCATION OF MNCs' TECHNOLOGICAL ACTIVITIES IN EUROPE: AGGLOMERATIVE TENDENCIES AND OTHER TERRITORIAL EXTERNALITIES

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1. Introduction

It has been demonstrated elsewhere (Cantwell and Iammarino, 1998, 1999; Cantwell and Noonan, 1999) that the existing knowledge base plays an important role in the decisions of the largest foreign-owned firms as to where to locate technological activities. Thus, in each country the local technological efforts of foreign-owned firms tend to be strongly agglomerated at a sub-national and regional level. The present paper analyses whether this agglomeration effect depends linearly on the cross-regional distribution and the regional specialisation of technological activities in indigenous firms, or whether foreign-owned firms are instead also attracted to certain places by other location-specific variables and territorial externalities. Specifically, the purpose of this paper is threefold: (i) to analyse the regional distribution of technological activities carried out by large multinational corporations (MNCs) in Europe over the last 30 years, and to investigate whether US-owned and European-owned MNCs behave differently; (ii) to examine the locational preferences of foreign-owned firms across the European regions having allowed for a linear sector-specific agglomeration effect; and (iii) to explain and empirically test such preferences on the basis of territorial and dynamic externalities.

The empirical investigation uses patents granted in the US to the world's largest industrial firms for inventions achieved in their European-located operations, classified by the host European region in which the research facility responsible is located. We examine the regional distribution of corporate research activity in Italy, Germany and the UK, distinguishing between domestically-owned, foreign but other European-owned and US-owned firms in each of these three countries. The patent data allow us to identify

separately the location of the inventor (corporate research facility) and the home country of the ultimate corporate owner, the parent company of the relevant group. The spatial patterns of activity in indigenous and foreign-owned firms is then compared using a methodology developed by Mariotti and Piscitello (1995), which establishes departures from a linear proportionality between the locational distributions of different sets of firms, controlling for the degree of correlation between the profiles of technological specialisation of each set, since co-specialised firms are more likely to be co-located. We find that there are significant differences in the cross-regional distribution of technological development between locally-owned and foreign-owned firms, and also between (foreign) European-owned and US-owned MNCs. We discuss some explanations for these differences, which are associated with the co-evolution of alternative corporate technological trajectories and local innovation systems.

The paper is organised in the following way. Section 2 investigates the extent and evolution of the internationalisation of technological activity at the national and industry level in the period 1969-95, by using patents granted to the largest firms in the US. Section 3 – by classifying corporate patenting by the location at the regional level of the research facility responsible for the invention - explores the locational issue at the regional level for Germany, the UK and Italy over the whole period 1969-95, and investigates whether the research activities carried out in the European regions considered follow a similar geographical profile for both domestically- and foreign-owned firms. Finally, Section 4 presents some summarising and concluding remarks, draws out one of the policy implications of our argument, and indicates an agenda for future research.

2. The globalisation of corporate technology at the national and sectoral level

At a general level, a firm's operations may be dispersed across different types of productive activity (the diversification of technologies or products), or over geographical space (the internationalisation of the same). However, the analysis of technologies and product markets is different in this respect. Spreading the product markets in which the firm is involved may be a matter of exploiting more effectively established competencies, while moving into new areas of technological development means creating new

competence. In order not just to exploit effectively but also to consolidate an existing capability, it is generally necessary for a firm to extend that capability into new related fields of production and technology, and across a variety of geographical sites (Cantwell, 1995). The corporate internationalisation and diversification of technological activity are indeed both ways of spreading the competence base of the firm, and of acquiring new technological assets, or sources of competitive advantage. The background to this study is the relationship between the diversification and internationalisation of the technological competence of large MNCs, which have been explored extensively in our earlier work (Cantwell and Piscitello, 1999a; 1999b; Cantwell and Janne, 1999).

The use of corporate patents as an indicator of advanced technological capacity and the ability to develop innovation is one of the most established and reliable methods of estimating the cross-sectional patterns of innovative activities. The advantages and disadvantages of using patent statistics are well known in the literature (Schmookler, 1950, 1966, Pavitt, 1985, 1988; Griliches, 1990; Archibugi, 1992). The use of patent records provides information both on the owner of the invention (from which the country of location of the ultimate parent firm has been derived through a consolidation of patents at the level of international corporate group), and separately the address of the inventor, thus allowing the identification of where the research and development underlying the invention was carried out in geographical terms. The regionalisation of our US patent database consists of attributing a revised, although still compatible, NUTS 2 code for each patent record, according to the location of inventors in the EU countries, with reference to the period 1969-1995 (Cantwell and Iammarino, 1998; 1999). Moreover, patents can be classified by detailed technological fields (grouped into 56 sectors in the database, see the Appendix), which would not be possible otherwise by using indicators such as for example, R&D expenditure (Zander, 1997).

Table 1 examines the share of US patents of the world's largest firms attributable to overseas research in terms of the nationality of the parent company. The general trend is upwards – from a foreign research share of 10.5% in 1969-72 to 16.5% in 1991-95, excluding Japanese firms – although this is disguised in the overall global average foreign share owing to the sharply rising contribution to total corporate patenting of Japanese companies, whose research has been little internationalised. The most significant increase in internationalisation is found in the two most recent periods. While a significant

increase in foreign technological development already started for most of the national groups of companies in 1987-90, all the groups moved to a greater internationalisation of technological activity in the early 1990s; even those which have had in the past a somewhat more centralised approach to their research strategy, such as the Japanese and, more relevantly for the present study, the Italian. Furthermore, the trend increase in the internationalisation of research has been most stable and marked in US and Swedish companies since 1969, and in German and French firms since 1983.

Looking at the locational issue from the parent's company viewpoint, Table 2 shows that the R&D activities of European companies abroad are concentrated in the US (over 50% on average) and elsewhere in Europe (about 40% in average). In particular, the share of US patents of European-owned companies attributable to foreign-located research undertaken within Europe has risen from 30.2% in 1969-72 to 40.4% in 1991-95, although this trend seems to have been partially reversed in the early 1990s. The US is the most important location for German- and British-owned research abroad, with more than half of their total foreign research accounted for by that location, indicating a reliance upon more widely "globalised" technological strategies encompassing facilities outside Europe. French firms have also a significant part of their technological activity abroad in the US, while Italian companies recently showed a sharp increase in their preference for other European locations.

Concerning the dispersion of foreign-owned research activities across the European economy, Table 3 indicates the share of European host countries in the foreign-located research of large firms. In particular, it is shown that overall the most attractive European host countries for the technological activity of foreign-owned MNCs were Germany (29% in 1991-95), the UK (21%) and France (16%), and only to a lesser extent Italy (6%). Since 1969-72 the UK has lost some of its earlier share (29%) to most other countries.

Table 4 reports figures by European host country on the share of foreign-owned firms in total corporate patents emanating from locally-based research. The proportion of European research activity undertaken by foreign-owned companies has increased overall from 23% to 29%, having fallen slightly during the 1970s and then risen during the 1980s, before rising sharply in the 1990s. This is consistent with the general increase in the internationalisation of technological development in the major firms displayed in Table 1 (from a foreign share of 10.5% to one of 16.5%, excluding Japanese companies).

The sectoral forms of foreign penetration in the major European countries is shown in Tables 5 and 6, which examine the contribution to local research of foreign-owned firms by industry (Table 5) and by the field of technological activity derived from the US patent class system (Table 6). Looking first at Table 5, in the world as a whole foreign penetration is highest in the chemicals, pharmaceuticals, oil and food product industries. In Europe instead, while the same applies in oil and food products, the foreign-owned share of local development is below average in chemicals (15.6% as against 24.0%), and only slightly above average (at 27.4%) in pharmaceuticals. This is because of the strength of indigenous companies in the European chemicals and pharmaceuticals industries. In contrast, foreign penetration is above average in Europe in the group of electrical equipment, professional and scientific instruments, and especially in office and computing equipment. These are the industries in which European-owned firms are technologically weakest vis-à-vis their US and Japanese rivals, and so the European economies have become relatively more dependent on the locally conducted research of foreign-owned firms. Similar explanations can be applied to the variations across individual host countries. Foreign penetration is not especially high in food products in the UK, in oil in the UK, Italy or France, in electrical equipment in France, or in office and computing equipment in Italy. In each of these cases large indigenous companies have a comparative technological advantage. The one interesting exception to this argument is the high foreign penetration into UK research in pharmaceuticals, an industry in which the UK is a centre of technological excellence. In this instance, the interaction between the innovation of indigenous and foreign-owned companies has taken the form of a virtuous circle of increased activity on both sides (Cantwell, 1987, 1989).

Turning to the equivalent disaggregation of foreign penetration in European development by the type of technological activity (Table 6), the general world background reveals two apparent differences from the industry-based picture. Foreign penetration is relatively low in oil-related chemicals, but above average in mechanical engineering. This suggests that the oil companies are using their high foreign-located development more in relation to mining and mechanical technologies rather than for innovation in petrochemicals, and indeed a similar pattern may apply to a lesser extent to firms in other industries. In Europe, again, foreign penetration is relatively low (unlike in the rest of the world) in the development of chemical and pharmaceutical technologies,

but relatively high in the electrical equipment, office and computing equipment, and instruments group, and also in metals and machinery. Conversely again, foreign penetration in pharmaceutical development in the UK is higher than its status as a centre of excellence might suggest, but owes to the positive interaction between UK-owned and the best foreign-owned companies. Foreign participation in new drug development is also high in France, but this is probably attributable to the local regulatory regime, which has insisted on the presence of local research facilities as a condition of local medical sales.

3. The European regional level

From the above discussion, it becomes quite clear that foreign investment in innovation has as much a regional scope as it has a national one. In particular, recent trends in the EU support the conjecture that a comparative analysis at the sub-national scale is the most appropriate way to identify the effects of globalisation (Cantwell and Iammarino, 1999). Although some authors have recently suggested that regions are increasingly becoming important *milieux* for competitive enhancing activities of mobile investors (Porter, 1996, 1998; Scott, 1998; Dunning, 1999), thus replacing the nation state as the principal spatial economic entity (Ohmae, 1995), the empirical research on the locational issue is still quite scant.

In order to throw some light on the circumstances that lead to the geographical dispersion of technological activities and that give rise to geographical agglomeration, we examined three of the largest European countries involved in the globalisation process (namely Germany, the UK and Italy) at a more detailed level of analysis. In particular, we consider the locational pattern of MNCs' technological activities within and across the countries and investigate whether locational preferences differ between foreign-owned and domestically-owned firms, and amongst the former between European- and US-owned firms**.**

3.1 *Methodological Issues*

In order to understand the geographical pattern of innovation in Europe, we referred to sub-national entities that derive from normative criteria, as classified by Eurostat in the

Nomenclature of Territorial Units for Statistics (NUTS). The NUTS classification is based on the institutional divisions currently in force in the member states, according to the tasks allocated to territorial communities, to the sizes of population necessary to carry out these tasks efficiently and economically, and to historical, cultural and other factors.

To provide a single uniform breakdown of territorial systems we referred to the NUTS 2 level for the three countries considered. The NUTS 2 level (206 Basic Regions) is generally used by the EU members for the application of their regional policies, and thus is the most appropriate to analyse the regional distribution of technological activities. Indeed, although other studies about various regional issues in the EU consider different sub-national NUTS levels for different countries in order to assure economic homogeneity[1], in the present context considering NUTS 2 assures a more uniform distribution of patent data across regions in the period considered. The one exception is that in the case of Lombardia, which is comfortably the largest region for technological development in Italy, we created a sub-division between Milano and the rest of Lombardia. The empirical investigation uses patents granted to the world's largest industrial firms for inventions achieved in their European-located operations, classified by the host European region in which the responsible research facility is located.

3.2 *The Location of MNC Technological Activities in the European Regions by Foreign-Owned and Indigenous Firms*

The regionalisation of the University of Reading patent database has been extended to cover Germany, UK and Italy. The three host countries substantially differ each other in terms of the magnitude of the phenomenon under investigation. Indeed, the total number of corporate patents due to German-located activity registered in the database over the period 1969-1995 (106,383) is more than twice that registered for the UK (46,253), which in turn is more than five times that registered for Italy (8,756)[2].

[1] For example Paci (1997) considers 109 regions corresponding to NUTS 0 for Denmark, Luxemburg, Ireland; NUTS 1 for Belgium, Germany, Netherlands, and the UK; and NUTS 2 for Italy, France, Spain, Portugal and Greece. Likewise, Cantwell and Iammarino (1998a, b) consider NUTS 1 for UK and NUTS 2 for Italy.

[2] It is worth observing that this is partly due to the very different policy approaches adopted in the three countries (see Cantwell and Iammarino, 1998b).

Tables 7a-7c report the total number and the percentage share of patents granted to the domestic firms and to foreign-owned firms in each region considered[3]. Concerning Germany (see Table 7a) it is worth noting that the number of patents granted to domestic firms is more than twice that for foreign-owned firms, while for both the UK and Italy the efforts of indigenous and foreign-owned firms are of similar magnitude. As explained already, in the UK this is due to a high degree of both inward and outward internationalisation, while in Italy it is due in large part to the comparative weakness of very large indigenous companies in the Italian industrial structure. It is interesting to observe that while the pattern of regional concentration of the local technological efforts of indigenous and foreign-owned firms is similar in the UK (in London and South East England) and in Italy (in Milano), there is a significant difference in Germany. The leading centre for domestically-owned innovation in Germany is Oberbayern, but foreign-owned development is concentrated instead mainly in Stuttgart and Darmstadt.

3.3 *The Asymmetry in the Geographical Distribution of Foreign-Owned MNC vs. Domestically-Owned Corporate Technological Activities*

Having illustrated the geographical distribution of the technological activity carried out by domestic and foreign-owned firms across the European regions of the largest economies, the main issue is whether our observation of the similarity (in the UK and Italy) or the difference (in Germany) between indigenous and foreign-owned firms with respect to the single major centre of activity can be extended to an analysis of the regional distribution of activity as a whole. That is, are there significant asymmetries between the geographical distribution of foreign firm activity compared to that of domestically-owned firms? In particular, we investigate whether a linear proportionality mapping from the geographical dispersion of indigenous company activity (a linear agglomeration effect) would exhaustively explain foreign-owned firms' locational patterns, or whether the effect is instead more complex and reinforced by territorial and region-specific externalities.

[3] The regions considered meet a size restriction which we had to impose in order to avoid small number problems. Specifically, the cut off point has been imposed on the domestic side, that is we excluded all the regions which did not account more than 25 patents granted to indigenous firms in the whole period considered. Such a cut off point left us with 35 regions for Germany (out of the original 38), 33 for the UK (from 35) and 9 in the case of Italy (out of 20).

The problem has been tackled as follows (for a similar technical approach applied to the manufacturing foreign direct investment [FDI] in Italy and in USA see Mariotti and Piscitello, 1995, and Shaver, 1998, respectively[4]). Let N_{jm} be the total number of patents granted to foreign firms in each sector j in country m. If the location of technological activities by foreign firms were exclusively related to the technological activities and to technological specialisation of domestic firms, then the N_{jm} patents would be distributed in each region i of country m, in proportion to the total number of patents granted in the same region to domestic firms in sector j. Therefore:

let n_{ijm} be the total number of patents granted to domestic firms in region i, sector j and country m in the period considered. For each sector, the share of patents granted to domestic firms in region i with respect to the national average is:

$\alpha_{ij} = n_{ijm}/\Sigma_i n_{ijm}$

Assuming that foreign firms follow a random process in the location of their technological activities, the expected number of patents $\tilde{n}_{ijm}$ granted to foreign firms in region i, sector j and country m is:

$\tilde{n}_{ijm} = \alpha_{ij} * N_{jm}$

Consequently, the expected total number $\tilde{N}_{im}$ of patents granted to foreign firms in each region i in country m is:

$\tilde{N}_{im} = \Sigma_j \tilde{n}_{ijm} = \Sigma_j \alpha_{ij} * N_{jm}$

where:

m = Germany, UK, Italy;

i = 1, …, 77;

j = 1, …, 56

Therefore, it is possible to compare the distribution of the expected values $\tilde{N}_{im}$ with the number of patents actually granted to the foreign firms in each region of the country, N_{im}, during the period considered. The statistically significant equality of the two distributions would imply that the activity of domestic firms, that is the existing knowledge base in each region, explains almost perfectly the locational choices of technological activities by foreign firms in that country.

In order to compare the two distributions, a chi-square test has been carried out. Since the equality between the expected and actual distributions is significantly rejected ($p<$

[4] Another approach to the evaluation of firms' location tendencies in Europe is Mur and Trivez (1998).

.01) for all the cases considered, this means that foreign technological activities are distributed dissimilarly within each country considered compared to the existing patterns of technological activities carried out by domestic firms (which confirms previous results by Cantwell and Iammarino 1998; 1999) and that therefore the linear agglomeration effect hypothesis can be significantly rejected.

To provide an appropriate measure of such a discrepancy between foreign and domestic locational behaviour in the three countries considered, we built a variable based on the difference between the two profiles obtained (that is N_{im} and $\tilde{N}_{im}$). In particular, a proper measure of such a difference should take into account (i) the regional size, and (ii) the degree of co-specialisation between indigenous firms in region i and foreign-owned firms in the country m, while controlling for (iii) general sector-specific differences in the propensity to patent. Therefore, the absolute difference between N_{im} and $\tilde{N}_{im}$ should be corrected through a normalisation factor taking into account the three effects just mentioned, which is given by the following:

$I_{im} = (n_{im}/s)*\Sigma_j rta_{ijm}*RTA_j$

where

n_i is the measure of the regional size (that is the number of patents granted to the domestic firms);

s is the number of technological sectors considered (s = 56 in our study);

$\Sigma_j rta_{ijm}*RTA_j$ measures the extent of technological co-specialisation between domestic and foreign-owned firms. In particular:

$rta_{ijm} = (n_{ijm}/n_{im})/(w_j/w)$ and $RTA_j = (N_j/N)/(w_j/w)$

where w denotes the total world patenting (i.e. of large firms in the US from facilities anywhere in the world).

Finally, the variable $PREFERENCE_{im}$, which measures the attractiveness of the individual region i in country m for foreign investors, is defined as:

$$PREFERENCE_{im} = (N_{im} - \tilde{N}_{im})/I_{im}$$

In order to take into account any home country specificity, the variable considered can be further specified as follows:

$$PREFERENCE_{imk} = (N_{imk} - \tilde{N}_{imk})/I_{imk}$$

where k in our case can assume two different values referring either to European-owned firms or US-owned firms[5].

This index might vary theoretically between -∞ and +∞, in proportion to the attractivness of the i-th region, by virtue of its endowment of location factors. *Coeteris paribus*, when the value of the variable is positive (negative), it means that foreign firms have been granted there more (less) patents than expected under the hypothesis of a perfect proportionality with the patents granted to the domestic firms.

3.4 *Favoured Locational Patterns of Foreign-Owned Firms Across the Regions within each European Country and across European Regions*

In order to analyse whether the locational behaviour adopted by foreign European- and US-owned firms follow similar patterns, Table 8 shows the correlation coefficients for the locational preferences of the two sets of foreign-owned firms (European or US, with each other and with the whole set of foreign-owned firms combined) across German, UK and Italian regions respectively. Interestingly, the locational pattern of foreign-owned technological activities as a whole in Germany seems to be led more by other European than by US firms (the correlation coefficients are 0.862 and 0.608, respectively), while there is no correlation between the two individually. Conversely US firms' locational behaviour (likewise uncorrelated with the European) seems to drive the spatial distribution of technological activities in Britain (the coefficient is 0.892, while that for European-owned firms is 0.585); while for Italy, perhaps partly because of the small numbers involved, European- and US-owned firms similarly contribute (the correlation coefficient is 0.788) to the distribution of technological activities across regions.

Furthermore, to reveal at a deeper level of detail MNCs' regional locational preferences in the three European countries considered, Tables 9a-9c report the values of the index PREFERENCE for the regions within each country for the whole set of foreign-owned firms as well as for European- and the US-owned firms respectively. Likewise, Tables 10a-10c report the corresponding ranking of the regions themselves. The differences in locational distribution between foreign European-owned and US-owned corporate technological development is also illustrated in Figures 1a-1c.

[5] It is worth noting that i = 1,.., 35 when k = Germany; i = 1,…, 33 when k = UK and i = 1,…9 in the

The geographical patterns shown by Tables 9, 10 and Figure 1 may be related to our earlier discussion of the sectoral patterns of foreign penetration of the national research base in each of the host countries in question in Tables 5 and 6. Thus, we saw earlier for example, that in Germany foreign-owned firms contribute relatively much in electrical and computing equipment and in general engineering, but relatively little in chemicals, the area of greatest indigenous strength. This suggests that foreign-owned firms may be less attracted to the main centres for chemical research in Germany (in Nordrhein Westfalen), but disperse their technological efforts more widely across other areas. For US-owned firms this is almost exactly the pattern observed in Tables 9a and 10a, and Figure 1a, and for foreign European-owned firms it is more or less accurate as well. The value of our indicator of relative locational attractiveness is negative for US firms for all the regions of Nordrhein Westfalen (Arnsberg, Köln, Detmold, Dusseldorf and Munster) and their rankings lie between 22 and 30 (out of 34); while for foreign European-owned firms the same is true for Detmold, Dusseldorf and Munster (with rankings between 25 and 29), but the indicator is just positive for Arnsberg (ranked 15), and Köln (ranked 12) is a partial exception. On the other hand, foreign-owned firms are not especially attracted either to the regions of Bayern, which is the least distinctive of the German macro(NUTS1)-regions, in that the technological specialisation of domestically-owned firms located there is very broadly dispersed (Cantwell and Noonan, 1999). Here the picture is clearest for foreign European-owned companies, for which Niederbayern, Mittelfranken, Oberfranken and Oberbayern are all negative and lowly ranked (between 28 and 32), and Oberpfalz ranks lowest of all. However, for US-owned firms Oberfranken and Niederbayern rank slightly higher (at 18 and 19 out of 34), while Oberpfalz is a clear exception, being the most highly ranked region in terms of relative attractiveness for US-owned affiliate development.

The most attractive macro-region for foreign-owned R&D is Baden-Würtemburg, that as a centre of engineering excellence in the motor vehicle industry (in which sphere of technology creation it is very highly specialised) has proved a magnet for foreign-owned development efforts in the areas of electrical and computing equipment, and general engineering (Cantwell and Noonan, 1999). This area is also well known for the innovativeness of local small and medium-sized firms (SMEs), whose

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Italian case.

expertise in developing specialised machinery, equipment and components and in engineering may also provide a fruitful interaction with the R&D of large foreign-owned firms. For both foreign European-owned and US-owned firms these regions in ascending order of attractiveness are Stuttgart, Tübingen (ranked 10th for both), Karlsruhe (ranked 7th for both) and Freiburg (which has the 2nd highest ranking in both cases).

Turning now to the British experience, let us recall from Table 5 that foreign-owned firms contribute most to the UK research base again in mechanical engineering, electrical and computing equipment and instruments; they have also participated well in the British success in pharmaceuticals research, and they have made a roughly average contribution in chemicals. As a general consequence, the development efforts of foreign-owned firms in the UK are most attracted as we have seen already to the wider technology base and infrastructure of the higher order centre of London and the South East (Table 7b), and this is especially true in the fields of electrical equipment and pharmaceuticals (Cantwell and Iammarino, 1999). Foreign-owned efforts are relatively much less attracted to the lower order centres of the North West and the West Midlands than indigenous activity might suggest, but insofar as they are active there they match local specialisation in chemicals in the North West, and in engineering and transport equipment in the West Midlands.

Tables 9b, 10b and Figure 1b help to provide more detailed evidence. In the South East, Hampshire and the Isle of Wight are highly relatively attractive both for foreign European-owned firms (ranked 4 out of 33) and US-owned firms (ranked 2nd). Yet while the research of foreign European-owned companies is relatively oriented to Greater London (ranked 8) and Surrey and Sussex (ranked 2), US-owned firms are relatively more drawn to Kent (ranked 12) and the Thames Valley (ranked 9); while Essex is moderately ranked (at 14) by both groups. Conversely, neither foreign European-owned nor US-owned firms are relatively attracted to West Midlands county or to Hereford, Worcestershire and Warwickshire (in the West Midlands), or to Merseyside, Lancashire or Cheshire (in the North West). The one exception is Greater Manchester, which is highly ranked (at 5) for other European-owned firms, but not for US-owned companies (ranked 30). It may be that other European-owned, and particularly German-owned firms are especially attracted by the local expertise in

chemicals available in the Manchester area, given that this is the major field of German technological strength and hence outward asset-seeking investment.

In the Italian case as well foreign-owned firms make their greatest contribution to the domestic research base in general engineering, electrical equipment (other than computing equipment) and in pharmaceuticals (Table 5). We know that the development efforts of foreign-owned firms are drawn even in relative terms to the major centre of Lombardia, due to the availability of general technological skills and wider infrastructure there, rather than for any particularly specialised expertise (Cantwell and Iammarino, 1998). However, Tables 9c, 10c and Figure 1c reveal an interesting twist to this story. It is Lombardia outside Milano that is relatively most attractive for the siting of R&D by foreign-owned firms, while Milano itself is ranked only moderately by US-owned firms, and actually has a negative indicator value for foreign European-owned companies. This may be consistent with what we know of the lack of technological co-specialisation between indigenous and foreign-owned firms in Lombardia as a whole (Cantwell and Iammarino, 1998). While foreign-owned companies are keen to access the regional infrastructure, as latecomers (compared to the established domestically-owned firms) they wish to do so while avoiding the costs of congestion within Milano itself.

Looking more widely at an inter-country perspective on the locational preference of foreign-owned firms as between the regions of alternative European countries once companies have decided to locate their technological activities in Europe, we adapt the model thus far employed at the single country level to the situation in which foreign activities could in principle spread over the whole set of the European regions considered. In particular, in order to avoid problems related to the mixed presence of German and British foreign firms within the set of the European foreign-owned firms, we restricted this part of our analysis to US-owned firms alone[6]. Therefore, we considered the distribution of the total number of patents granted to the US firms in the period 1969-1995 over the 77 regions considered. The results are shown in Table 11, in which the rankings are compared as between the cross-country and within country perspectives.

[6] Not only are US firms easily the major national group developing technology in Europe without a local home base there, but of patents due to inventions from foreign-owned facilities in Germany, Italy and the UK, the number granted to US-owned firms is larger than that due to all other foreign-owned companies taken together, and so US firms are likely to lead overall foreign behaviour.

The effects of this comparison are quite interesting. As might be expected given the historical orientation of US FDI in Europe towards the UK, once we allow for locational competition between regions across national borders rather than just within them, the British regions tend the rank more highly and the German regions lower in their relative attractiveness to US-owned MNCs. Yet it is the regions of South East England that seem to benefit most from the cross-country regional perspective (notably Hampshire and the Isle of Wight, and Kent), as well as a couple of Scottish regions (Borders and Grampian) which are less important in terms of overall activity (Table 7b). On the German side the anomaly posed by Oberpfalz looks much less stark in the cross-border setting, as it's ranking drops from 4 to 21. For the Italian regions the effect of the wider international comparison is to increase the variance of the cross-regional rankings. Milano and the rest of Lombardia, Veneto and Friuli Venezia Giulia are ranked more highly (although Lazio and Emiglia Romagna fall a bit), while Piemonte and Toscana are ranked lower in the wider cross-country context.

4. Summary and Conclusions

Since the late 1970s (Cantwell and Piscitello, 1999b), large MNCs have increasingly extended or diversified their fields of technological competence through their use of internationally integrated networks for technological development. In each location in such a network MNCs tap into specialised sources of local expertise, and so differentiate their technological capability, by exploiting geographically separate and hence distinct streams of innovative potential. However, as we have seen above, the form of potential which is accessed in alternative regional centres varies. In lower order locations like North West England foreign-owned firms focus upon access to specific expertise deriving from the local strength in chemicals (Cantwell and Iammarino, 1999). More precisely, it seems that German-owned MNCs in the chemical industry have been attracted by the technological resources of Greater Manchester, wishing to incorporate the local chemical capabilities from that area into their corporate networks. Conversely, in parts of South East England, or in Lombardia outside Milano, and in certain German regions, foreign-owned MNCs are attracted to extend their attempts at competence

creation by a broader range of technological expertise and engineering skills, and by local infrastructure. Yet within these latter regions at a more detailed geographical level we have also found some further locational specificities in terms of the types of competence development that are most likely to be established locally. While Hampshire, Lombardia and Freiburg seem generally attractive to firms of most national backgrounds, Kent, Berkshire and Oberpfalz appeal mainly to US-owned firms, while Surrey, Sussex, Greater London and Köln are relatively more attractive for the siting of the development efforts of other European-owned MNCs.

The recent emergence of internationally integrated MNC networks is best observed in Europe, where the contribution of foreign-owned MNCs to national technological capabilities is much greater than elsewhere. About one-quarter of large firm R&D carried out within in Europe has been conducted under foreign ownership (and this figure had risen to nearly 29% by the early 1990s), while the world average is only just over one-tenth. Part of the reason is that European-owned MNCs are the most internationalised in their strategies for technology development, while much of their foreign-located R&D has remained within Europe, and their European orientation has increased (from a 30% share of foreign R&D in Europe in the late 1960s, to a 40% share by the 1990s). However, it is important to understand that these intra-European networks have significant links with US technology creation as well. The international networks of British-owned and German-owned MNCs are largely US-oriented, while US-owned MNCs remain European-oriented in their foreign location of R&D, despite the lower degree of internationalisation of competence creation in US firms and some fall in their share of foreign activity located in Europe (since their share in Europe still remains at over one-half).

As a consequence of the establishment of these international corporate networks for the diversification of technological competence, in many European regions in particular both inward and outward direct investment (FDI) have become important as a facilitator of local technological specialisation, in a supporting framework that includes cross-border knowledge flows within MNCs between selected regional centres of excellence. Given the complexity and interdependence of modern technological systems the most dynamic centres of innovation require an ever-increasing intensity of such knowledge flows, which should therefore be encouraged as a matter of policy. This policy conclusion is worth emphasising, since it is the reverse of the central thrust of the

conventional outlook upon technology policy, the major concern of which has been to counteract problems associated with a lack of appropriability of returns on investment in new knowledge creation if knowledge 'leaks out' too freely to those that did not fund its development (Cantwell, 1999). Instead, in inter-linked networks innovation rises with the intensity of knowledge flows between complementary branches of technological development, since outward and inward knowledge flows become part of a mutual structure that feeds into the local learning that generates corporate technological capabilities, and it is these capabilities that typically earn a return rather than the individual knowledge inputs into learning. Each participating region finds itself increasingly integrated into an international division of labour for the development of new technological systems.

For the leading or higher order regional centres this provides an opportunity for them to widen their technology base as they play host to MNC networks across a broader range of fields of competence development, and become engaged in a broader set of knowledge flows with other centres. In lower order or more narrowly technologically specialised regions foreign-owned MNCs are more often attracted by their fairly specific fields of local innovative potential. So in this second category of regions MNC networks create opportunities to deepen specialised regional technological excellence, to further differentiate their capabilities in what has become their focal area of expertise, and to gain access to complementary resources and related knowledge in the major centres elsewhere.

Thus, the presence of technological development in foreign-owned firms tends to compensate for weaknesses in the indigenous research base of the European economies, partly through the higher shares of foreign-owned MNCs in local technology creation that are typically associated with industries and fields in which indigenous firms are weaker, but also because of the international linkages MNCs provide in support of the activities in which indigenous firms are stronger. In addition, the cross-border networks of MNCs coordinate mutual innovative strengths between the leading centres of excellence across countries (as in the case of the outward and inward investment associated with the UK pharmaceutical industry). As a result, MNC asset-seeking investment is attracted to the major regions for technological development by the generic skills and infrastructure that can be found locally. In the UK and Italy the attractiveness of the leading centres is linked as well to specific skills in the main fields of innovation of

indigenous firms – such as pharmaceuticals in the UK and the South East region, and specialised machinery in Italy and Lombardia. Instead in Germany indigenous firms are themselves much more highly regionally differentiated, so that the leading region for chemical development is not also the most generally attractive to the broader range of foreign-owned company development. For this reason foreign-owned development has tended to be dispersed more widely (as foreign-owned specialisation does not match the indigenous profile), and has been attracted most to Baden Würtemburg, with the greatest background engineering skills and which offers innovative linkages to SMEs.

We have suggested that foreign-owned firms establish facilities for competence creation in regions either because of their general expertise, engineering skills and infrastructure, or as a means of accessing more specialised capabilities, and that the relative significance of these motives varies between regions. In particular, the former are more significant in higher order centres with substantial levels of development. Yet, as the German experience shows, not all higher order centres are automatically attractive for this reason; some such centres may remain fairly narrowly focused in their innovative efforts even though their overall level of development is high, and this may not be attractive to firms outside the industry of excellence. This suggests that the relative attractiveness of regions to the technological efforts of foreign-owned MNCs depends upon (i) the regional level of development, (ii) the degree (breadth) of local technological specialisation in the region, and (iii) whether the composition of local specialisation includes a focus on mechanical technologies and engineering skills (and perhaps also in electrical engineering and computing) which provide a linkage between technological development in a wide variety of areas. Our results are broadly consistent with these three propositions. However, it remains to explore them more fully statistically in future research, while allowing for the possible role of other regional effects, such as the extent and composition of the local science base, which may influence the level of corporate technological development efforts sited in each region by each substantial group of foreign-owned companies.

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Table 1 - Share of US patents of the world's largest firms attributable to research in foreign locations, organised by the nationality of the parent firms, 1969-95 (%)

Nationality of the parent firm	1969-72	1973-77	1978-82	1983-86	1987-90	1991-95
US	4,96	5,89	6,40	7,53	7,91	8,62
Germany	12,77	11,05	12,07	14,47	17,05	20,72
UK	43,08	41,24	40,47	47,09	50,42	55,79
Italy	13,39	16,03	13,85	12,59	11,14	16,47
France	8,16	7,74	7,17	9,19	18,17	33,17
Japan	2,63	1,88	1,22	1,26	0,92	1,08
Netherlands	50,40	47,37	47,65	53,99	53,96	55,69
Belgium-Lux	50,36	51,11	49,28	58,15	47,53	53,25
Switzerland	44,36	43,63	43,78	41,59	42,99	52,47
Sweden	17,82	19,90	26,20	28,94	30,60	42,42
Austria*	5,06	16,76	19,84	11,82	8,00	0,00
Norway*	20,00	1,67	12,31	32,50	37,14	20,22
Finland*	18,87	27,11	26,89	18,67	27,94	39,49
Canada	41,19	39,30	39,49	35,82	40,12	43,96
Others	28,21	22,22	26,37	30,34	7,54	3,94
Total	10,04	10,53	10,50	10,95	11,28	11,27
excluding Japan	10,52	11,59	12,25	13,87	15,76	16,53
European countries**	28,01	25,19	24,52	26,95	29,99	34,78

Source: US patent database developed by John Cantwell at the University of Reading, with the assistance of the US Patent and Trademark Office.
* Number of patents less than 50 for several periods.
** Including: Germany, UK, Italy, France, Netherlands, Belgium-Lux, Switzerland, Sweden, Denmark, Ireland, Spain, Portugal, Greece, Austria, Norway and Finland.

Table 2 - Patenting activity attributable to foreign-located research , by host country and nationality of the parent firms, 1969-95 (%)

	Europe					
Nationality of the parent firm	1969-72	1973-77	1978-82	1983-86	1987-90	1991-95
Germany	42,66	49,22	31,40	25,09	22,04	26,92
UK	15,44	18,16	22,40	23,99	24,91	27,17
Italy	33,94	25,54	25,49	48,51	53,57	81,00
France	43,56	59,52	51,80	55,66	68,07	45,69
Total European countries	30,16	37,29	39,53	41,34	41,84	40,39
US	74,20	73,69	73,91	73,27	68,36	57,06
Japan	51,43	26,24	11,27	16,33	19,68	18,94

	USA					
Nationality of the parent firm	1969-72	1973-77	1978-82	1983-86	1987-90	1991-95
Germany	51,53	38,29	60,30	60,13	62,59	64,16
UK	76,87	72,77	68,56	66,04	66,21	66,10
Italy	59,63	72,83	73,20	50,50	42,86	18,00
France	51,11	33,04	42,81	31,50	29,13	49,95
Total European countries	63,55	55,76	54,44	50,25	50,19	53,12
Japan	43,33	67,93	84,86	83,42	77,15	74,45

	Rest of the World					
Nationality of the parent firm	1969-72	1973-77	1978-82	1983-86	1987-90	1991-95
Germany	5,81	12,49	8,30	14,78	15,37	8,92
UK	7,69	9,07	9,04	9,97	8,88	6,73
Italy	6,43	1,63	1,31	0,99	3,57	1,00
France	5,33	7,44	5,39	12,84	2,80	4,36
Total European countries	6,29	6,95	6,03	8,41	7,97	6,49
US	25,80	26,31	26,09	26,73	31,64	42,94
Japan	5,24	5,83	3,87	0,25	3,17	6,61

Source: As for Table 1.

Table 3 - Patenting activity attributable to European-located foreign-owned research, across host countries, 1969-95 (%)

	Total patents from foreign-owned facilities					
European host country	1969-72	1973-77	1978-82	1983-86	1987-90	1991-95
Germany	27,03	30,23	31,81	35,63	33,47	28,87
UK	29,34	26,78	25,03	22,63	21,00	21,15
Italy	4,34	4,94	4,37	4,50	5,97	6,46
France	13,21	14,95	14,52	14,21	14,92	15,60
Rest of Europe	26,08	23,10	24,27	23,03	24,64	27,92
Total Europe	100,00	100,00	100,00	100,00	100,00	100,00

Source: As for Table 1.

Table 4 - Patenting activity attributable to foreign-owned research, as a proportion of all patenting from the local research of large firms, by European host country, 1969-95 (%)

	Proportion of patents from foreign-owned facilities					
European host country	1969-72	1973-77	1978-82	1983-86	1987-90	1991-95
Germany	16,32	15,57	15,16	18,77	18,09	17,37
UK	27,66	30,80	31,30	36,00	35,44	45,23
Italy	27,32	31,09	26,49	32,85	43,93	57,50
France	24,17	24,73	24,04	25,13	27,05	28,94
Total Europe	22,70	21,63	21,43	24,40	24,97	28,63

Source: As for Table 1.

Table 5 - US patents from corporate research located in each host country due to foreign-owned firms, by the industrial group of the parent company, 1969-95 (%)

Sector	Germany	UK	Italy	France	Europe	World
Food, Drink, and Tobacco	99,64	15,45	100,00	55,25	44,55	22,24
Chemicals	6,49	29,55	31,97	33,31	15,57	14,21
Pharmaceuticals	13,91	50,34	100,00	19,34	27,37	16,16
Metals	9,87	29,62	63,87	11,20	13,25	10,32
Mechanical Engineering	25,84	47,16	100,00	52,00	26,93	12,47
Electrical Equipment	30,01	43,48	91,32	27,85	30,48	9,74
Office Equipment	86,34	76,71	21,87	56,76	67,36	10,34
Motor Vehicles	8,35	13,18	7,67	21,83	12,28	5,68
Aircraft and Aerospace	15,18	10,54	100,00	2,85	13,00	2,39
Coal and Petroleum Products	80,47	19,43	12,07	10,31	39,25	15,08
Professional Instruments	29,90	97,79	100,00	100,00	45,62	3,37
Other Manufacturing	56,64	26,71	26,13	30,66	35,16	10,39
Total	16,87	33,73	36,60	25,86	23,97	10,81

Source: As for Table 1.

Table 6 - US patents from corporate research located in each host country due to foreign-owned firms, by the type of technological activity, 1969-95 (%)

Sector	Germany	UK	Italy	France	Europe	World
Food, Drink, and Tobacco	30,85	20,73	61,11	45,71	34,76	13,62
Chemicals	8,09	35,54	31,58	21,19	18,40	12,49
Pharmaceuticals	8,05	41,55	38,57	37,61	23,40	18,79
Metals	28,78	34,86	43,27	20,37	27,97	10,41
Mechanical Engineering	25,73	28,35	40,56	26,58	27,26	12,14
Electrical Equipment	25,13	39,45	60,08	28,66	28,81	9,36
Office Equipment	29,37	50,53	34,40	40,46	34,74	7,84
Motor Vehicles	7,01	20,79	10,14	21,62	11,33	5,57
Aircraft and Aerospace	9,09	0,87	33,33	4,76	5,40	2,58
Coal and Petroleum Products	14,14	18,32	10,34	9,09	25,84	8,62
Professional Instruments	20,63	37,05	23,65	30,58	27,32	8,77
Other Manufacturing	16,33	19,75	19,49	16,06	20,86	9,33
Total	16,87	33,73	36,60	25,86	23,97	10,81

Source: As for Table 1.

Table 7a - Number (and share) of patents granted to domestic, EU, US and total foreign-owned firms in the German regions

	Domestic firms		European firms		US firms		total foreign firms	
Regions	N.	%	N.	%	N.	%	N.	%
Stuttgart	7768	10,20	422	5,25	1427	20,34	1851	12,17
Karlsruhe	2755	3,62	519	6,46	473	6,74	992	6,52
Freiburg	808	1,06	885	11,02	455	6,49	1342	8,82
Tubingen	1089	1,43	281	3,50	317	4,52	599	3,94
Oberbayern	10785	14,16	120	1,49	244	3,48	381	2,51
Niederbayern	819	1,08	32	0,40	58	0,83	90	0,59
Oberpfalz	559	0,73	17	0,21	264	3,76	283	1,86
Oberfranken	533	0,70	22	0,27	67	0,96	89	0,59
Mittelfranken	3806	5,00	318	3,96	93	1,33	422	2,77
Unterfranken	1238	1,63	554	6,90	39	0,56	593	3,90
Schwaben	1101	1,45	97	1,21	165	2,35	284	1,87
Berlin	1875	2,46	51	0,63	88	1,25	141	0,93
Brandenburg	56	0,07	12	0,15	12	0,17	24	0,16
Bremen	128	0,17	28	0,35	19	0,27	47	0,31
Hamburg	315	0,41	648	8,07	105	1,50	754	4,96
Darmstadt	9195	12,07	708	8,81	1236	17,62	1959	12,88
Giessen	650	0,85	112	1,39	56	0,80	191	1,26
Kassel	174	0,23	24	0,30	11	0,16	47	0,31
Meckelenburg-Vorpommern	94	0,12	19	0,24	4	0,06	24	0,16
Braunschweig	913	1,20	50	0,62	52	0,74	110	0,72
Hannover	1048	1,38	274	3,41	215	3,06	495	3,25
Luneburg	349	0,46	51	0,63	95	1,35	147	0,97
Weser-Ems	280	0,37	19	0,24	21	0,30	41	0,27
Dusseldorf	9444	12,40	613	7,63	335	4,78	951	6,25
Koeln	9586	12,59	1052	13,10	428	6,10	1484	9,76
Munster	1345	1,77	100	1,24	34	0,48	135	0,89
Detmold	300	0,39	17	0,21	27	0,38	44	0,29
Arnsberg	1268	1,66	170	2,12	107	1,53	282	1,85
Koblenz	585	0,77	246	3,06	99	1,41	351	2,31
Trier	253	0,33	27	0,34	59	0,84	86	0,57
Rheinhessen-Pfalz	6212	8,16	105	1,31	206	2,94	322	2,12
Saarland	137	0,18	31	0,39	31	0,44	62	0,41
Sachsen	112	0,15	13	0,16	19	0,27	33	0,22
Schleswig-Holstein	511	0,67	384	4,78	144	2,05	530	3,49
Thuringen	66	0,09	12	0,15	10	0,14	22	0,14
Total	*76157*	*100,00*	*8033*	*100,00*	*7015*	*100,00*	*15208*	*100,00*

Table 7b - Number (and share) of patents granted to domestic, EU, US and total foreign-owned firms in the British regions

	Domestic firms		European firms		US firms		total foreign firms	
Regions	N.	%	N.	%	N.	%	N.	%
Cleveland, Durham	629	2,70	23	0,72	57	0,72	82	0,70
Cumbria	136	0,58	0	0,00	19	0,24	19	0,16
Northumberland, Tyne and Wear	166	0,71	20	0,63	142	1,78	164	1,40
Humberside	213	0,91	30	0,94	35	0,44	66	0,56
North Yorkshire	362	1,55	15	0,47	89	1,12	107	0,91
South Yorkshire	199	0,85	22	0,69	111	1,39	133	1,13
West Yorkshire	255	1,09	55	1,72	97	1,22	157	1,34
Derbyshire, Nottinghamshire	921	3,95	32	1,00	103	1,29	143	1,22
Leicestershire, Northamptonshire	503	2,16	19	0,60	277	3,48	319	2,71
Lincolnshire	61	0,26	3	0,09	66	0,83	71	0,60
East Anglia	342	1,47	312	9,78	273	3,43	621	5,28
Bedfordshire, Hertfordshire	1528	6,55	238	7,46	1093	13,72	1353	11,51
Berks, Buckshire, Oxon	1669	7,15	133	4,17	1017	12,77	1231	10,47
Surrey, Sussex	1703	7,30	732	22,95	477	5,99	1250	10,64
Essex	991	4,25	199	6,24	596	7,48	815	6,93
Greater London	2487	10,66	389	12,20	839	10,53	1300	11,06
Hampshire, Isle of Wight	463	1,98	133	4,17	574	7,21	801	6,82
Kent	574	2,46	19	0,60	405	5,08	432	3,68
Avon, Gloucestershire, Wiltshire	1103	4,73	87	2,73	255	3,20	370	3,15
Cornwall, Devon	64	0,27	9	0,28	52	0,65	62	0,53
Dorset, Somerset	166	0,71	33	1,03	28	0,35	65	0,55
Hereford&Worcester, Warwickshire	983	4,21	10	0,31	95	1,19	135	1,15
Shropshire, Staffordhire	620	2,66	22	0,69	60	0,75	90	0,77
West Midlands	2200	9,43	12	0,38	131	1,64	187	1,59
Cheshire	1161	4,98	138	4,33	94	1,18	235	2,00
Greater Manchester	1202	5,15	285	8,94	129	1,62	455	3,87
Lancashire	516	2,21	21	0,66	74	0,93	98	0,83
Merseyside	1100	4,71	33	1,03	97	1,22	132	1,12
Clwyd, Dyfed, Gwynedd, Powys	153	0,66	3	0,09	62	0,78	66	0,56
Gwent, Mid-South-West Glamorgan	398	1,71	19	0,60	296	3,72	323	2,75
Borders-Central-Fife-Lothian-Tayside	175	0,75	16	0,50	166	2,08	187	1,59
Dumfries&Galloway, Strathclyde	251	1,08	127	3,98	103	1,29	231	1,97
Grampian	42	0,18	0	0,00	53	0,67	53	0,45
Total	*23336*	*100,00*	*3189*	*100,00*	*7965*	*100,00*	*11753*	*100,00*

Table 7c - Number (and share) of patents granted to domestic, EU, US and total foreign-owned firms in the Italian regions

	Domestic firms		European firms		US firms		total foreign firms	
Regions	N.	%	N.	%	N.	%	N.	%
Piemonte	1430	32,52	168	16,18	119	10,43	287	12,84
Milano	1986	45,17	397	38,25	613	53,72	1020	45,62
Lombardia	274	6,23	207	19,94	211	18,49	431	19,28
Veneto	127	2,89	61	5,88	25	2,19	86	3,85
Friuli Venezia Giulia	87	1,98	12	1,16	4	0,35	16	0,72
Emilia Romagna	186	4,23	102	9,83	64	5,61	169	7,56
Toscana	107	2,43	24	2,31	12	1,05	36	1,61
Umbria	52	1,18	2	0,19	1	0,09	3	0,13
Lazio	148	3,37	65	6,26	92	8,06	188	8,41
Total	*4397*	*100,00*	*1038*	*100,00*	*1141*	*100,00*	*2236*	*100,00*

Source: As for Table 1.

Table 8 - Correlation between regional localisation patterns of European, US and the total foreign-owned firms

Within the German regions			Within the British regions			Within the Italian regions		
	EU firms	US firms		EU firms	US firms		EU firms	US firms
EU firms			EU firms			EU firms		
US firms	0,201		US firms	0,182		US firms	0,788	
Tot.foreign	0,862	0,608	Tot.foreign	0,585	0,892	Tot.foreign	0,917	0,891

Source: As for Table 1.

Table 9a - Patterns of foreign localisation of the EU, US and total foreign-owned firms in the German regions

EU firms		US firms		total foreign-owned firms	
Hamburg	95,68	Oberpfalz	54,50	Hamburg	97,42
Freiburg	49,71	Freiburg	21,75	Freiburg	77,91
Schleswig-Holstein	42,34	Luneburg	20,64	Schleswig-Holstein	43,49
Unterfranken	26,92	Saarland	12,51	Oberpfalz	33,74
Koblenz	20,57	Trier	11,12	Koblenz	25,95
Giessen	16,33	Hamburg	11,09	Saarland	23,75
Karlsruhe	12,02	Karlsruhe	10,47	Karlsruhe	21,32
Saarland	10,73	Schleswig-Holstein	10,43	Tubingen	20,47
Hannover	8,96	Darmstadt	9,99	Luneburg	20,08
Tubingen	8,41	Tubingen	9,98	Unterfranken	18,64
Brandenburg	8,19	Brandenburg	8,47	Giessen	18,63
Koeln	7,10	Hannover	6,00	Brandenburg	18,14
Thuringen	5,69	Koblenz	5,53	Hannover	16,19
Luneburg	3,68	Sachsen	5,23	Thuringen	9,99
Arnsberg	0,83	Thuringen	2,83	Trier	8,05
Meckelenburg-Vorpommern	0,64	Stuttgart	2,77	Sachsen	5,38
Sachsen	0,40	Schwaben	2,05	Darmstadt	5,26
Kassel	0,09	Oberfranken	0,33	Koeln	3,35
Bremen	-0,59	Niederbayern	-1,01	Schwaben	1,35
Schwaben	-1,39	Bremen	-1,03	Kassel	0,98
Darmstadt	-2,08	Kassel	-1,06	Arnsberg	-0,25
Trier	-2,25	Arnsberg	-1,19	Stuttgart	-1,06
Weser-Ems	-2,30	Weser-Ems	-1,70	Bremen	-1,52
Braunschweig	-2,49	Koeln	-1,92	Weser-Ems	-3,88
Munster	-3,00	Giessen	-2,22	Niederbayern	-5,32
Stuttgart	-3,37	Detmold	-2,69	Meckelenburg-Vorpommern	-5,57
Dusseldorf	-4,66	Rheinhessen-Pfalz	-2,99	Dusseldorf	-5,79
Niederbayern	-5,97	Braunschweig	-3,57	Oberfranken	-6,16
Detmold	-6,30	Dusseldorf	-3,98	Munster	-7,18
Mittelfranken	-6,85	Munster	-6,90	Detmold	-7,22
Oberfranken	-10,32	Unterfranken	-7,12	Braunschweig	-8,14
Oberbayern	-10,77	Meckelenburg-Vorpommern	-7,47	Rheinhessen-Pfalz	-8,63
Rheinhessen-Pfalz	-11,58	Berlin	-8,21	Mittelfranken	-10,51
Berlin	-12,64	Oberbayern	-9,53	Berlin	-18,55
Oberpfalz	-14,81	Mittelfranken	-10,90	Oberbayern	-21,55

Table 9b - Patterns of foreign localisation of the EU, US and total foreign-owned firms in the British regions

EU firms		US firms		total foreign-owned firms	
East Anglia	77,99	Lincolnshire	94,70	East Anglia	138,63
Surrey, East_West Sussex	30,68	Hampshire, Isle of Wight	69,97	Hampshire, Isle of Wight	102,39
Dumfries&Galloway, Strathclyde	18,40	Northumberland, Tyne and Wear	59,36	Lincolnshire	76,19
Hampshire, Isle of Wight	13,81	Borders-Central-Fife-Lothian-Tayside	48,66	Northumberland, Tyne and Wear	67,59
Greater Manchester	7,90	East Anglia	45,50	Borders-Central-Fife-Lothian-Tayside	53,72
Cornwall, Devon	1,98	Bedfordshire, Hertfordshire	38,35	Bedfordshire, Hertfordshire	40,34
Bedfordshire, Hertfordshire	1,27	Grampian	33,82	Grampian	35,67
Greater London	1,07	Gwent, Mid-South-West Glamorgan	28,58	Gwent, Mid-South-West Glamorgan	28,76
West Yorkshire	0,37	Berkshire, Buckinghamshire, Oxfordshire	26,27	Cornwall, Devon	27,57
Northumberland, Tyne and Wear	0,04	Cornwall, Devon	19,88	Dumfries&Galloway, Strathclyde	25,29
Dorset, Somerset	-0,61	South Yorkshire	19,69	Surrey, East_West Sussex	23,89
South Yorkshire	-1,70	Kent	16,06	Berkshire, Buckinghamshire, Oxfordshire	19,09
Avon, Gloucestershire, Wiltshire	-1,78	Clwyd, Dyfed, Gwynedd, Powys	15,19	South Yorkshire	16,48
Essex	-1,80	Essex	14,72	Kent	10,51
Humberside	-2,03	Leicestershire, Northamptonshire	13,25	Essex	10,44
Borders-Central-Fife-Lothian-Tayside	-3,93	Dumfries&Galloway, Strathclyde	5,02	Leicestershire, Northamptonshire	6,52
Cheshire	-4,25	Greater London	-2,76	Greater London	-1,48
North Yorkshire	-4,38	North Yorkshire	-5,88	Clwyd, Dyfed, Gwynedd, Powys	-6,16
Gwent, Mid-South-West Glamorgan	-4,49	Avon, Gloucestershire, Wiltshire	-6,08	Avon, Gloucestershire, Wiltshire	-8,97
Grampian	-4,89	Surrey, East_West Sussex	-8,77	West Yorkshire	-12,25
Derbyshire, Nottinghamshire	-5,78	West Yorkshire	-9,78	Greater Manchester	-12,99
Kent	-6,84	Cumbria	-11,61	North Yorkshire	-13,85
Berkshire, Buckinghamshire, Oxfordshire	-6,99	Lancashire	-16,62	Cumbria	-25,42
Lancashire	-7,09	Derbyshire, Nottinghamshire	-18,99	Humberside	-26,19

Hereford&Worcester, Warwickshire	-7,37	Hereford&Worcester, Warwickshire	-19,32	Lancashire	-29,09
Leicestershire, Northamptonshire	-7,74	Merseyside	-19,53	Hereford&Worcester, Warwickshire	-29,71
Cumbria	-8,16	Humberside	-21,38	Derbyshire, Nottinghamshire	-30,29
West Midlands	-9,41	West Midlands	-22,84	Dorset, Somerset	-31,16
Shropshire, Staffordhire	-9,61	Dorset, Somerset	-24,40	Merseyside	-33,98
Merseyside	-11,98	Greater Manchester	-25,96	West Midlands	-37,33
Cleveland, Durham	-16,48	Shropshire, Staffordhire	-27,20	Shropshire, Staffordhire	-42,00
Clwyd, Dyfed, Gwynedd, Powys	-17,54	Cleveland, Durham	-30,24	Cheshire	-44,95
Lincolnshire	-18,87	Cheshire	-35,75	Cleveland, Durham	-46,30

Table 9c - Patterns of foreign localisation of the EU, US and total foreign-owned firms in the Italian regions

EU firms		US firms		total foreign-owned firms	
Emilia Romagna	38,29	Lazio	41,98	Lazio	105,78
Lombardia	29,32	Lombardia	26,38	Lombardia	76,19
Lazio	25,95	Emilia Romagna	13,55	Emilia Romagna	66,15
Veneto	6,14	Milano	5,20	Veneto	3,86
Toscana	0,34	Veneto	4,06	Milano	3,37
Friuli Venezia Giulia	-1,00	Friuli Venezia Giulia	3,17	Toscana	-7,97
Milano	-1,92	Piemonte	-3,58	Piemonte	-9,78
Piemonte	-3,48	Toscana	-4,63	Friuli Venezia Giulia	-11,16
Umbria	-13,34	Umbria	-39,74	Umbria	-65,66

Source: As for Table 1.

Table 10a - German regions ranked by European, US and total foreign-owned firms

	Total foreign	European firms	US firms
Hamburg	1	1	6
Freiburg	2	2	2
Schleswig-Holstein	3	3	8
Oberpfalz	4	35	1
Koblenz	5	5	13
Saarland	6	8	4
Karlsruhe	7	7	7
Tubingen	8	10	10
Luneburg	9	14	3
Unterfranken	10	4	31
Giessen	11	6	25
Brandenburg	12	11	11
Hannover	13	9	12
Thuringen	14	13	15
Trier	15	22	5
Sachsen	16	17	14
Darmstadt	17	21	9
Koeln	18	12	24
Schwaben	19	20	17
Kassel	20	18	21
Arnsberg	21	15	22
Stuttgart	22	26	16
Bremen	23	19	20
Weser-Ems	24	23	23
Niederbayern	25	28	19
Meckelenburg-Vorpommern	26	16	32
Dusseldorf	27	27	29
Oberfranken	28	31	18
Munster	29	25	30
Detmold	30	29	26
Braunschweig	31	24	28
Rheinhessen-Pfalz	32	33	27
Mittelfranken	33	30	35
Berlin	34	34	33
Oberbayern	35	32	34

Table 10b - British regions ranked by European, US and total foreign-owned firms

	Total foreign	European firms	US firms
East Anglia *(E. Anglia)*	1	1	5
Hampshire, Isle of Wight *(Hampshire)*	2	4	2
Lincolnshire	3	33	1
Northumberland, Tyne and Wear *(Northumberland)*	4	10	3
Borders-Central-Fife-Lothian-Tayside *(Lothian)*	5	16	4
Bedfordshire, Hertfordshire *(Beds&Herts)*	6	7	6
Grampian	7	20	7
Gwent, Mid-South-West Glamorgan *(Gwent)*	8	19	8
Cornwall, Devon *(Devon&Cornwall)*	9	6	10
Dumfries&Galloway, Strathclyde *(Strathclyde)*	10	3	16
Surrey, East-West Sussex *(Surrey&Sussex)*	11	2	20
Berks, Bucks, Oxon *(Thames Valley)*	12	23	9
South Yorkshire *(S. Yorkshire)*	13	12	11
Kent	14	22	12
Essex	15	14	14
Leicestershire, Northamptonshire *(Leics&Northants)*	16	26	15
Greater London *(London)*	17	8	17
Clwyd, Dyfed, Gwynedd, Powys *(Clwyd)*	18	32	13
Avon, Gloucestershire, Wiltshire *(Avon)*	19	13	19
West Yorkshire *(W. Yorkshire)*	20	9	21
Greater Manchester *(Manchester)*	21	5	30
North Yorkshire *(N. Yorkshire)*	22	18	18
Cumbria	23	27	22
Humberside	24	15	27
Lancashire	25	24	23
Hereford&Worcester, Warwickshire *(Warwickshire)*	26	25	25
Derbyshire, Nottinghamshire *(Derby&Notts)*	27	21	24
Dorset, Somerset *(Dorset)*	28	11	29
Merseyside	29	30	26
West Midlands *(W. Midlands)*	30	28	28
Shropshire, Staffordhire *(Staffs)*	31	29	31
Cheshire	32	17	33
Cleveland, Durham *(Cleveland)*	33	31	32

Table 10c - Italian regions ranked by European, US and total foreign-owned firms

	Total foreign	European firms	US firms
Lazio	1	3	1
Lombardia	2	2	2
Emilia Romagna	3	1	3
Veneto	4	4	5
Milano	5	7	4
Toscana	6	5	8
Piemonte	7	8	7
Friuli Venezia Giulia	8	6	6
Umbria	9	9	9

Table 11 - Rank assigned to the European regions by US-owned firms

Regions	across countries	within countries		across countries	within countries
Hampshire, Isle of Wight	1	2	Stuttgart	40	39
Borders-Central-Fife-Lothian-Tayside	2	5	Hannover	41	30
Grampian	3	9	Darmstadt	42	27
Lincolnshire	4	1	Schwaben	43	40
Northumberland, Tyne and Wear	5	3	Cumbria	44	66
East Anglia	6	6	Thuringen	45	38
Lombardia	7	11	Greater Manchester	46	74
Bedfordshire, Hertfordshire	8	8	Cleveland, Durham	47	76
Kent	9	17	Lancashire	48	67
Gwent, Mid-South-West Glamorgan	10	10	Merseyside	49	70
Cornwall, Devon	11	15	Oberfranken	50	41
Berkshire, Buckinghamshire, Oxfordshire	12	12	Cheshire	51	77
Lazio	13	7	Derbyshire, Nottinghamshire	52	68
Essex	14	19	Arnsberg	53	45
South Yorkshire	15	16	Dorset, Somerset	54	73
Freiburg	16	13	Hereford&Worcester, Warwickshire	55	69
Leicestershire, Northamptonshire	17	21	Niederbayern	56	42
Dumfries&Galloway, Strathclyde	18	34	Bremen	57	43
Oberpfalz	19	4	Toscana	58	55
Emilia Romagna	20	20	Giessen	59	48
Clwyd, Dyfed, Gwynedd, Powys	21	18	Koeln	60	47
Hamburg	22	24	Rheinhessen-Pfalz	61	51
West Yorkshire	23	64	Dusseldorf	62	54
Luneburg	24	14	Piemonte	63	53
Milano	25	33	Weser-Ems	64	46
Greater London	26	50	Detmold	65	49
Surrey, East-West Sussex	27	62	West Midlands	66	72
Tubingen	28	28	Kassel	67	44
Trier	29	23	Berlin	68	61

Schleswig-Holstein	30	26	Umbria	69	78
Saarland	31	22	Braunschweig	70	52
Brandenburg	32	29	Munster	71	58
North Yorkshire	33	56	Unterfranken	72	59
Avon, Gloucestershire, Wiltshire	34	57	Shropshire, Staffordhire	73	75
Koblenz	35	*31*	Friuli Venezia Giulia	74	36
Veneto	36	35	Meckelenburg-Vorpommern	75	60
Karlsruhe	37	25	Mittelfranken	76	*65*
Humberside	38	37	Oberbayern	77	63
Sachsen	39	32			

Appendix - Sectoral groups

1	Food and tobacco products
2	Distillation processes
3	Inorganic chemicals
4	Agricultural chemicals
5	Chemical processes
6	Photographic chemistry
7	Cleaning agents and other compositions
8	Disinfecting and preserving
9	Synthetic resins and fibres
10	Bleaching and dyeing
11	Other organic compounds
12	Pharmaceuticals and biotechnology
13	Metallurgical processes
14	Miscellaneous metal products
15	Food, drink and tobacco equipment
16	Chemical and allied equipment
17	Metal working equipment
18	Paper making apparatus
19	Building material processing equipment
20	Assembly and material handling equipment
21	Agricultural equipment
22	Other construction and excavating equipment
23	Mining equipment
24	Electrical lamp manufacturing
25	Textile and clothing machinery
26	Printing and publishing machinery
27	Woodworking tools and machinery
28	Other specialised machinery
29	Other general industrial equipment
30	Mechanical calculators and typewriters
31	Power plants
32	Nuclear reactors
33	Telecommunications
34	Other electrical communication systems
35	Special radio systems
36	Image and sound equipment
37	Illumination devices
38	Electrical devices and systems
39	Other general electrical equipment
40	Semiconductors
41	Office equipment and data processing systems
42	Internal combustion engines
43	Motor vehicles
44	Aircraft
45	Ships and marine propulsion
46	Railways and railway equipment
47	Other transport equipment
48	Textiles, clothing and leather
49	Rubber and plastic products

50	Non-metallic mineral products
51	Coal and petroleum products
52	Photographic equipment
53	Other instruments and controls
54	Wood products
55	Explosive compositions and charges
56	Other manufacturing and non-industrial