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The Influence of Clustering on MNE Location and Innovation in Great Britain

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The Influence of Clustering on MNE Location and Innovation in Great Britain

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Abstract

This paper addresses two questions: what, if anything, is the influence of geographic concentration of economic activity on patterns of foreign direct investment; what is the relationship, if any, between geographic concentration of economic activity, multinationality and innovation. The paper identifies the consensus view which is emerging in the literature, based on both theory and evidence, that strong clusters are likely to be attractive for inward direct investment and that they promote innovation. The paper tests whether this relationship is evident in Great Britain using data derived from the UK's Annual Foreign Direct Investment survey and the UK's Community Innovation Survey 2007. It addresses a surprising gap in the emerging literature by also examining the relationship between cluster strength and *outward* direct investment, thereby testing Porter's (1990) claim in *The Competitive Advantage of Nations*, that advantages gained in strong clusters would be the foundations of international competitiveness. The paper also distinguishes between two different types of agglomeration economy, localisation economies based on collocation of firms in related lines of activity, and urbanisation economies based on the overall concentration of economic activity in a particular region, a distinction most of the emerging literature in International Business has not made clear. The first set of models examine the propensity to engage in outward direct investment and the geographic pattern of foreign ownership of firms active in Great Britain and find that both are positively related to cluster strength, with localisation economies being more important than urbanisation economies. Two models of innovation are estimated, the first examines what factors influence firms to be innovative and the second what influences innovation effort as measured by R&D intensity. In both cases there is evidence that regional agglomeration promotes innovation and that there are stronger effects flowing from own industry agglomeration than from broader regional scale.

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1. INTRODUCTION

Research on the foreign direct investment (FDI) activities of multinational enterprises (MNEs) has a long and rich tradition (Dunning, 2001). Research on the advantages, disadvantages and processes that arise in business clusters has a similar tradition (Marshall, 1890; Porter, 1998). Whilst it is clear that there is a considerable amount of MNE FDI in clusters (Kozul-Wright and Rowthorn, 1998), that FDI is relatively highly concentrated geographically (Shatz and Venables, 2000) and that this activity is increasing (Nachum, 2003), the body of research on this interface is small (Birkinshaw and Solvell, 2000). However, it is growing fast in the face of increased globalisation, deregulation and advances in information and communication technology all of which have begun to prompt a re-evaluation of the spatial organization of MNE activity (Buckley and Ghauri, 2004). This paper adds to the growing numbers of studies which focuses on agglomeration effects at the sub-national scale. The paper further addresses the neglected question of whether agglomeration promotes outward direct investment (ODI) as well as attracting inward investment. This neglect is somewhat surprising given that a central proposition of Porter (1990), which spurred strong academic and policy interest in clusters, was that location in clusters should promote international competitiveness.

It is likewise well-recognised in the literature that higher rates of innovation are associated with geographic clusters (Audretsch and Feldman 1996; Jaffe *et al.* 1993). There has also been considerable interest in the role of MNEs in innovation systems at a variety of geographic scales, both as sources of and beneficiaries from positive externalities, particularly knowledge spillovers, to and from geographic clusters. Overseas investment by MNEs related to R&D has risen sharply in the last two decades (Belderbos *et al.*, 2009) and overseas multinationals have come to account for a significant share of innovation expenditure, particularly in advanced industrialised countries, contributing both directly and indirectly, via localised spillovers, to domestic innovation in host economies (Erken and Kleijn, 2010). MNEs dominate private spending on R&D (Ambos, 2005), therefore the question of what attracts MNEs to particular locations is highly important in the context of regional development.

This study asks two related questions:

- (1) What is the relationship between clusters and multinational activity?

(2) To what extent do clustering and multinationality lead to higher rates of innovation activity?

The paper is structured as follows. Section 2 reviews the literature on the MNE /Clusters/Innovation interfaces. Section 3 details the methodology of the study. Sections 4 and 5, present the findings and discusses these in relation to the literature. A final section concludes.

2. LITERATURE ON THE MNE FDI/CLUSTERS INTERFACE

Clusters and multinational investment flows

Firm performance may improve if certain activities are located in clusters where higher levels of productivity (Henderson, 1986; Porter, 1998) and innovation (Baptista and Swann, 1998; Porter, 1998) may be achievable. In addition, clusters may be a focus for demand. The idea that firm-specific advantages might be developed in strong clusters has been a mainstay of Porter's work and that such advantages developed in home markets can be leveraged into overseas markets has a long tradition in theories of the MNE (Dunning, 2001). Since clusters are usually expensive and congested locations (Swann *et al.*, 1998), unless an activity needs to be located in a cluster, it will pay the MNE to move it elsewhere. Whilst this has in part been associated with outsourcing of lower value-added activities to low cost locations, higher value added activities remain focussed in more advanced economies (Mudambi, 2008). This relates to what Porter (1998) has dubbed the 'globalisation paradox', that easier movement of goods and people has increased the importance of hard to copy local advantages, which may exist in clusters, thus promoting an increased geographic concentration of activity.

There is a growing body of evidence that shows that MNEs are attracted to clusters (Gong, 1995; Head *et al.*, 1999; Wheeler and Mody, 1992) and that MNE FDI in clusters is increasing (Nachum, 2003). This evidence suggests that 'liability of foreignness' (Zaheer, 1995) is being compensated by the advantages of cluster location. Beyond so called 'fixed effects' (Swann *et al.*, 1998) – advantages that exist at a location that are not a function of the co-presence of related firms and institutions (for example, transportation links, climate, time-zone and cultural capital) – there are advantages that are directly related the co-presence of other firms that exists within a cluster. The majority of the literature acknowledges and builds on the classic insights of Marshall (1890) into the sources of superior performance in clusters (industrial districts in Marshall's terms):

labour market pooling, which in part brings benefits of a deeper division of labour and more highly specialised skills; the emergence of specialised input suppliers; and technological and knowledge spillovers. A distinction has long been made in the literature (Hoover, 1948) between two potential sources of dynamism: urbanization economies, which refer to the benefits of size and diversity of economic activity within an agglomeration; and localization economies which refer to the benefits of large scale *in a particular industry*, essentially related to the classic Marshallian externalities. Jacobs (1985) lays particular emphasis on the size and diversity of economic activity in city-regions as being critical to dynamism and innovation, ascribed to the free interchange of different ideas and the abundance and variety of resources, which may be required as inputs in producing innovation. As Capello (2002) recognises, both types of externality may be available in large metropolitan regions which can support significant clustering of activity in several industries.

What particular advantages which might attract inward direct investment? There is a large literature that attempts to explain MNE FDI in terms of the benefits that certain locations provide for investing MNEs. Dunning (1993) presents an FDI typology differentiating between investments that are ‘natural-resource seeking,’ ‘market-seeking,’ ‘efficiency-seeking,’ and ‘strategic-asset seeking.’ More recently, he has drawn from economic geography (Dunning, 1998) to elaborate the location element of his ‘OLI’ framework by incorporating clusters thinking. The idea that strategic-asset seeking and competence building are seen as being important influences on location decisions is consistent with this cluster thinking (Chen and Chen, 1998; Makino *et al.*, 2002; Rugman and Verbeke, 2007; Sethi *et al.*, 2003). Enright (1998) likewise elaborates a typology of contributions which particular overseas subsidiaries may make to their parents, two of which are relevant to this paper. ‘Listening posts’ aim to absorb knowledge from the cluster and then disseminate it within the wider enterprise (Dupuy and Gilly, 1999). Secondly, there is the subsidiary which absorbs ‘skills and capabilities’ from the cluster and then transfers these to the wider enterprise. The ability of MNEs to leverage knowledge and skills in this way may not be straightforward, however (Cohendet *et al.*, 1999).

The importance of location in major nodes is that much of the strategically important knowledge is tacit (Chung and Alcacer, 2003; Nachum and Keeble, 2003), and access to this knowledge is of paramount importance in high technology industries and complex service industries (Storper, 2000). Another important asset which firms may seek is

highly skilled labour (Makino *et al.*, 2002; Sethi *et al.*, 2003). It should be noted that agglomeration economies will not be equally relevant to all forms of FDI and may not be the reason why MNEs collocate (McCann and Mudambi, 2005). Pelegrin and Bolance (2008) find that FDI is attracted to agglomerations where there is high R&D intensity or where inter-firm linkages are an important characteristic of the industry, but not where cost-reduction is the primary objective of the FDI. In the latter case, favourable factor endowments are more important.

Studies by Birkinshaw and Hood (2000), Head *et al.*, (1999), Nachum (2000) and Wheeler and Mody (1992) show that MNEs can play a major role in cluster development and evolution, not simply being exploiters of benefits others have created. Much emphasis is placed in Pred's (1977) seminal analysis of dynamic cities on the importance of multilocal organisations (which may or may not be multinationals) as they will tend to be particularly wide conduits through which flows of goods, services, capital and information may flow. Bathelt *et al.* (2004) argue MNEs play a particularly important role in this respect. Amin and Thrift (1992) likewise argue persuasively that models which are just locally based do not recognise the importance of emerging global corporate networks and interconnected global city regions (Scott, 2001). There is, moreover, a self-reinforcing process whereby the more high level corporate activity a metropolis has, the more specialized services, labour and infrastructure it attracts. The fact that others are operating successfully in a given location may be taken as a credible signal of favourable demand and/or cost conditions, leading to imitation and herd behaviour (Henisz and Delios, 2001; Knickerbocker, 1973).

The literature has focussed on why clusters might attract inward investment from multinationals. The seminal contribution by Porter (1990) which sparked much of the interest in clusters among academics and policy-makers emphasised the role that strong clusters play in raising the international competitiveness of *domestic* firms. In the *Competitive Advantage of Nations* Porter concentrated on exporting as a prime indicator of such international competitiveness. Clearly this is not the only way in which it might be manifest. Dunning's (1993) eclectic paradigm makes clear that exporting will be the preferred mode of exploiting ownership advantages in the presence of transaction costs only where there is no locational advantage to establishing an overseas operation. Where there is, *outward* direct investment will be observed. Thus strong clusters, which may provide positive spillovers which attract inward investment, as much of the recent

literature has emphasised, might also be associated with outward investment as a manifestation of the benefits they bring to *domestic* firms.

Clusters, multinationals and innovation

The preceding section has established that there is an emerging literature which identifies a link between clusters and multinationals, and one which has a positive feedback loop in that strong clusters attract inward investment and may be fertile soil within which multinationals may grow, yet where multinationals, both domestic and overseas, may create positive spillovers. The linkage between clusters and innovation is well recognised in the literature, innovation being associated in particular with major technopoles, of which London and the M4 corridor is a prime example (Dicken, 2007). International linkages both directly in R&D and indirectly via market linkages may enhance the innovation performance of firms (Cantwell and Janne, 1999; Criscuolo, Narula and Verspagen, 2005; Frenz and Ietto-Gillies, 2009). Cantwell and Iammarino (2000) argue that multinationals will form their innovation networks selectively with some locations which are viewed as being more important being given greater priority.

The internationalisation of R&D is a process of quite long standing, with multinational firms having moved in the direction of dispersing their R&D capability over a number of centres (Zander, 2002; Evenson, 1984), although a rapid acceleration has been observed over the last two decades in particular (Belderbos *et al.*, 2009). Reasons for doing this range from minor innovation to adapt products better to local markets to developing a global R&D network whereby the firm is able to keep abreast of a wide range of technological trends and increase its chances of producing commercially viable innovations by having a genuinely dispersed R&D capability. Kuemmerle (1999) has characterised these two broad motivations as home-base exploiting and home-base augmenting FDI respectively and that these are clear strategic decisions, with the two types rarely mixed at the same location. Le Bas and Sierra (2002) nuance this typology by noting that firms may seek to augment their technological base both in situations where it is strong and the host country is strong and those where it is weak but the host country is strong. Furthermore, firms may acquire overseas firms for reasons other than technology exploitation or augmentation, but may nevertheless acquire overseas R&D facilities as a consequence. They find that these different strategies follow a clear pattern by industry and also differ by home country. Home-base augmenting subsidiaries are significantly more likely to be attracted to a location close to key “magnet” facilities such

as a university or public research institute, whereas home-base exploiting laboratories are more likely to be sited next to the firm's existing production operations or customers.

Following Jaffe *et al.* (1993), Audretsch and Feldman (1996) show how geographically concentrated innovation is and distinguish between factors which influence the geographic concentration of production and those which influence the geographic concentration of innovation. They find that the concentration of innovative activity is particularly marked for the most innovative industries. One of the key strands in the literature which explains why innovation should manifest such a high degree of geographic concentration is that of the innovative milieu (Camagni, 1991). This places emphasis on the social structures which underpin collective learning, one of the essential characteristics of innovation. These social structures typically experience a decay with distance and exchanging complex and/or tacit knowledge places a premium on face to face interaction. Jenkins and Tallman (2010) argue that MNEs will be attracted to particular clusters to access "sticky" knowledge which may complement their existing strengths and address weaknesses in their knowledge base. They define two key types of knowledge. Component knowledge relates to knowledge, skills and technologies relevant to particular elements of the organizational system. Architectural knowledge they define as "...an entire system of knowledge and the structures and routines for integrating its component knowledge into patterns for productive use and for developing new knowledge" (p3). They argue that architectural knowledge is particularly complex, tacit and organization-specific, hence it may be a source of lasting competitive advantage to firms as it is not readily imitable. The ability of firms to absorb new architectural knowledge from external clusters depends on the effort the firm makes in embedding itself into the cluster, formal linkages typically bringing more substantial benefits than informal relationships (see also Lee, 2009). In addition to local knowledge spillovers, competitive pressures and the ability to benchmark against other local firms and to observe which "experiments" in R&D appear to be relatively successful are further advantages of locating in a cluster (Beaudry and Breschi, 2003).

One approach to modelling the determinants of innovation is the innovation production function (Griliches, 1992). This captures the idea that there will be a vector of relevant inputs which will be transformed via some process into innovation outputs. At the firm level, there may be a variety of such inputs, which include labour, capital and private R&D expenditure. The quality and availability of the labour input may be influenced by clustering, insofar as more specialised, higher quality and deeper labour

pools will be characteristic of stronger clusters. Labour mobility is also a prime mechanism whereby knowledge spillovers occur in clusters. There may be spillovers from collaborators or competitors, customers, suppliers and private consultancies and research laboratories at the within the cluster. In addition, a particular cluster may be endowed with universities which will produce knowledge as well as an educated work force as well as, possibly, other publically funded research institutes.

The literature acknowledges a range of firm-specific attributes which are positively associated with innovation, such as size, age, human capital and market extension (Buesa *et al.*, 2010; Mansfield, 1963; Geroski, 1995; Cohen, 1995). There is some evidence that controlling for these effects weakens the link between clustering and innovation (Lee, 2009). The history of a firm may matter for a variety of reasons. A newly-established firm does not necessarily have the same likelihood of being innovative as other firms. The incidence of merger and acquisition implies that different knowledge assets are being combined, one example being the acquisition of an innovative biotechnology firm by a pharmaceutical company. One of the core concepts in the innovation literature is that of a technology trajectory (Dosi, 1982) and the associated idea that firms cannot usually make leaps to higher levels of technology without passing through a process of learning. This leads to the idea that a firm's past history of innovation will have a bearing on its propensity to be innovative in the current period. Such persistence of innovation can be demonstrated by evidence of activity in previous periods or by the use of patents or trademarks to protect the fruits of past innovation. Age may be a crude proxy for such accumulated learning. MNEs are apt to have several advantages over uninationa enterprises. They will typically be larger and have more extensive markets (Johansson and Lööf, 2008). They also tend to have larger R&D staffs and may as a consequence have higher absorptive capacity than other firms, which will give them an advantage in knowledge absorption and creation (Pfaffermayr and Bellak, 2002). That there exist significant differences in innovation intensity between industries is well-known in the literature (Patel and Pavitt, 1995; Cohen, 1995).

Summary

The preceding literature review suggests three testable hypotheses, which this study will examine:

1. Firms located in stronger clusters are more likely to engage in ODI
2. Overseas subsidiaries are more likely to be found in stronger clusters
3. Cluster strength is positively related to innovation

3. METHODOLOGY

The basic datasets on which this analysis was conducted are the UK's Annual Foreign Direct Investment (AFDI) Survey and the UK Community Innovation Survey (CIS) 2007. The AFDI survey examines outward and inward direct investment flows at the firm level and is claimed to be a census of such flows. The AFDI data was merged with a variety of additional databases maintained by the UK's Office for National Statistics to provide further information on firm-specific variables, although gaps in the matching fields used to merge databases did reduce the number of usable observations. Using the AFDI (outward) database, 3011 firms were identified which had engaged in outward direct investment between 2003 and 2005, of these 1895 firms were matched to other databases allowing further analysis. Enquiries with the Office for National Statistics indicated that whilst the corruption of the matching fields was a known issue, there was not believed to be any systematic pattern to it. On this basis, the 1895 firms may be viewed as a random sample from a larger population. Where the HQ could not be identified, the observations were dropped.

The CIS is based on a standardised set of questions, originating at EU level. CIS 2007 was sent to a stratified random sample of 28,000 UK businesses and received 14,872 replies. 1081 observations relating to Northern Ireland were dropped as these observations could not be linked to other databases and therefore a full analysis could not be performed on them. 235 observations were lost since they duplicated information on the same enterprise. A further 1025 observations were excluded from the analyses reported in the paper because there were conflicts between CIS and the Annual Respondents Database (ARD) either regarding their SIC classification, or in which region they were located, or both. These conflicts may have arisen due to the fact that the reporting units (and indeed the individual) to whom the CIS and ARD survey questionnaires may have been sent could have been at different establishments within the same enterprise if that enterprise operated at more than one site. Some conflicts may also have resulted from human error in completing the questionnaire. Results reported are not affected in any meaningful way by the omission of these problematic observations.

Participating in inward and outward investment

The first set of models estimated were logit regressions based on a 1,0 dependent variable depending on whether the firm was engaged in outward direct investment or not.

This analysis could not be performed for inward direct investment as data was not available on firms in other countries which do not direct investment flows to the UK. Instead an analogous logit model was run where the dependent variable took the value 1 where a firm was foreign-owned, 0 if domestic. The basic models have the form:

$$Y^*_i = \beta_1 \text{Size}_i + \beta_2 \text{Size}_i^2 + \beta_3 \text{Age}_i + \beta_4 \text{Age}_i^2 + \beta_5 \text{Locquo}_i + \beta_6 \text{Locquo}_i^2 + \beta_7 \text{Totemp}_i + \beta_8 \text{Totemp}_i^2 + \beta_9 \text{Ownemp}_i + \beta_{10} \text{Ownemp}_i^2 + \beta_{11} \text{Regdiv} + \beta_{12} \text{Foreign} + \sum_{i=1}^{i=n} \beta_{Ri} \text{Region}_i + \sum_{j=1}^{j=n} \beta_{SICj} \text{Industry}_i + u_i$$

where Y^*_i is a latent variable. The dummy variable Y_i takes the value 1 if $Y^*_i > 0$, 0 otherwise.

- Size was measured by the natural log of numbers of employees, due to the strong positive skew. This is *a priori* expected to be positive as larger firms are likely to have greater resources which will enable international activity. As for Age, Locquo, Totemp and Ownemp below, a squared term was included to allow for either the possibility of exponential increase beyond some critical mass, or possibly diminishing returns.
- Age is the age in years of the firm since first registration, sign expected positive. For subsidiaries of overseas MNEs, this is based on the age of the subsidiary.
- Locquo is the location quotient of the region in which the firm is located. The location quotient is constructed as the ratio of total employment in the firm's own 3-digit SIC industry in the region to that of total employment in that industry across Britain *divided by* the ratio of total employment in the region to all employment in Britain. The location quotient thus represents the extent of localization economies in the region. A quotient above 1 indicates that the region has a disproportionate share of employment in a particular industry relative to its total employment. The prior expectation is that the coefficient will be positive.
- Ownemp is measured as the log of total employment in the firm's 3-digit industry in the firm's region. This captures the absolute scale dimension of cluster strength within the firm's own industry. Sign expected positive.
- Totemp is total employment in the region. This crudely represents the extent of urbanization economies in the region. It also acts as a proxy for market size. Again the prior expectation is that this variable will have a positive sign.

- Regdiv is a Herfindahl index of the sum of squared market shares of 3-digit industries by employment within the firm's region. This is a measure of diversity, expected to take a negative sign as the smaller is the value, the more diversified the regional economy, which proxies urbanization externalities.
- Foreign is a dummy indicating foreign ownership. Most foreign-owned enterprises are associated with inward investment flows, but a small number (114) engage in outward direct investment. Since these are probably atypical, the control is included in the ODI model only. The sign is expected to be negative, since so few of the foreign-owned companies do send outward investment flows.
- A set of regional dummies was included to capture any regional fixed effects, for example London being the capital city, the South East having the closest proximity to continental Europe or the presence of magnet institutions.
- A set dummies was included to control for principal line of activity at the 2-digit SIC level (using 3-digit SIC dummies did not alter the substantive conclusions).

Propensity to be innovative

Following Johansson and Lööf (2008) and Robson and Haigh (2008), a firm was classed as being innovative if it had introduced a new or significantly improved good or service or a process innovation, or if it had engaged in any form of activity aimed at producing an innovation over the period 2004 to 2006. The latter activities encompass spending on internal R&D or training, acquisition of external knowledge or machinery and equipment linked to innovative activities. Firms were thus classified as having been innovative over the period, or not, and this dichotomous dependent variable was estimated using a logit model. The estimated equation was:

$$Y^*_i = \beta_1 \text{Size}_i + \beta_2 \text{Size}_i^2 + \beta_3 \text{Age}_i + \beta_4 \text{Locquo}_i + \beta_5 \text{Totemp}_i + \beta_6 \text{Ownemp}_i + \beta_7 \text{Regdiv} + \beta_8 \text{Marketglobal}_i + \beta_9 \text{MarketEU}_i + \beta_{10} \text{MarketUK}_i + \beta_{11} \text{HumanCap} + \beta_{12} \text{NewFirm}_i + \beta_{13} \text{M\&A}_i + \beta_{14} \text{ContInno}_i + \beta_{15} \text{Productivity}_i + \sum_{i=1}^{i=n} \beta_{Ri} \text{Region}_i + \sum_{j=1}^{j=n} \beta_{SICj} \text{Industry}_i + u_i$$

where Y^*_i is a latent variable. The dummy variable Y_i takes the value 1 if $Y^*_i > 0$, 0 otherwise. Squares of age and the regional variables were never significant, so were

omitted. New independent variables appearing in this model are as follows, otherwise variables are as defined in the previous section:

- Marketglobal is a dummy taking the value 1 if the firm's widest market is global in scale, MarketEU = 1 if the widest market is the EU, MarketUK = 1 if the widest market is the UK, the reference category is firms operating only at a sub-national scale, coefficients are expected to be positive and larger the wider is the scope of the firm's market as the firm will be able to spread R&D costs over a larger potential market and the firm may benefit from ideas drawn from a range of different markets.
- HumanCap is the ratio of employees with a degree or higher qualification to total employees, the sign is expected positive.
- NewFirm is a dummy taking the value 1 if the firm was formed in the last three years, sign expected positive as new firms are likely to be bringing a new product or service to market, even if it is only new to them.
- M&A is a dummy taking the value 1 if the firm was involved in a merger or acquisition within the last 3 years. A positive sign is expected, as one reason for M&As is to pass on control rights to innovative products, services or processes.
- ContInno is a dummy taking the value 1 where the firm was found to be innovative in the previous CIS, CIS4. This is an imperfect measure as only about half of the firms in CIS 2007 were also in CIS4. Sign expected positive.
- Productivity is sales per employee, a weak proxy, however value-added data was only available for a minority of firms in the data set.

Innovation effort

The final model has R&D intensity, measured as R&D expenditure per employee, as the dependent variable. The Heckman (1979) two-step procedure is the preferred method as observations of R&D expenditure are only possible for firms which have chosen to engage in innovation. Failing to take into account the fact that firms have made this prior choice leads to biased estimates. Results from the selection equation are very similar to the logit model described in the previous section, therefore are not separately reported. Brief details of included variables are reported as a note to table 4. The form of the second stage equation is:

$$\begin{aligned} \text{R\&DIntensity}_i = & \beta_1 \text{Size}_i + \beta_2 \text{Size}_i^2 + \beta_3 \text{Age}_i + \beta_4 \text{Locquo}_i + \beta_5 \text{Locquo}_i^2 + \\ & \beta_6 \text{Totemp}_i + \beta_7 \text{Ownemp}_i + \beta_8 \text{Ownemp}_i^2 + \beta_9 \text{Regdiv} + \beta_{10} \text{ProcInno}_i + \beta_{11} \text{Trademark}_i + \\ & \beta_{12} \text{Patent}_i + \beta_{13} \text{M\&A}_i + \beta_{14} \text{ContInno}_i + \sum_{i=1}^{i=n} \beta_{Ri} \text{Region}_i + \sum_{j=1}^{j=n} \beta_{SICj} \text{Industry}_i + u_i \end{aligned}$$

The only new variables appearing in this model are dummy variables which indicates whether the firm produced a process innovation within the last three years, whether it uses trademarks and whether it uses patents to protect innovations. Signs are all expected positive as these are proxies for a successful track record of innovation, which will give firms an incentive to continue their innovation effort. Trademark and Patent also capture crudely the appropriability of innovation effort in so far as their use implies some degree of effectiveness of the regime to protect intellectual property rights.

4. RESULTS

Engaging or Not in Outward Direct Investment

Table 1: Logit regression for probability of engaging in outward direct investment

Variable	Outward Direct Investment			
	Coefficient	Z	Marginal effect	
Size	0.9314	55.95	0.0007	***
Age	0.0047	1.32	0.000003	
Location quotient	0.1698	1.84	0.0001	*
Location quotient squared	-0.0221	-1.62	-0.00002	
Total regional employment	1.78*e ⁻⁷	1.73	1.32*e ⁻¹⁰	*
Total regional employment squared	-6.41*e ⁻¹⁵	-1.62	-4.75*e ⁻¹⁸	
Total own industry employment	-0.7820	-4.51	-0.0006	***
Own industry employment squared	0.0418	4.49	0.00003	***
Regional industry diversity	-30.89	-0.86	-0.0229	
London location	0.4315	2.61	0.0004	***
South East location	0.1631	1.25	0.0001	
Wales location	0.1706	0.71	0.0001	
Scotland location	0.2329	1.44	0.0002	
Foreign	-0.7457	-7.80	-0.0004	***
Industry dummies	Included			
N observations	546778			
Wald $\chi^2(55)$	Highly significant			
Pseudo-R ²	0.2532			

*** significant at 1% ** significant at 5% * significant at 10%

The strongest influence among the regional variables is the absolute scale measure of total employment in the region in the firm's own line of employment, which captures Marshallian localisation externalities. The positive coefficient on the square implies these positive externalities continue to grow as the cluster expands, which is implausible, but consistent with the idea that a cluster may experience rapid growth once it grows above a certain "critical mass". The results indicate that the location quotient is positively and significantly associated with the probability of engaging in outward direct investment. The result is robust to alternative specifications of the model (not reported). In this quadratic form, the negative marginal effect of the square of the location quotient, on the borderline for significance ($p=0.106$), indicates diminishing returns to cluster size, which is plausible due to worsening problems of congestion as a cluster grows. Urbanisation economies, as proxied by total regional employment, have only a small, but significant, influence with the signs of the coefficients implying an inverted-U relationship. The positive and significant coefficient on firm size and the positive and close to significant ($p=0.185$) coefficient on age are both reasonable. London is a major global node in the international economy, therefore it ought to provide a fertile environment from which to expand internationally, being fecund in access to market intelligence about overseas markets, an international labour pool, a pool of prospective partners with substantial experience of overseas markets (both foreign and domestic) and sources of specialist advice and finance. The positive, but not significant, coefficient on location in the South East is also reasonable in this context, given the close proximity of much of this region to London.

39 2-digit SIC dummies were included in the model, 38 of which were significant, most strongly so, and the 39th was just outside conventional significance (this was tested down to from a larger number of dummies with SIC45, construction, being the original reference category). The existence of significant industry effects on ODI activity is expected. The two industries with the highest positive marginal effects were oil and gas and office machinery and computers. Others in the top ranks of industries with large positive coefficients were chemicals, including pharmaceuticals, power generation, computer and related activities and pensions and insurance.

Inward investment

The results indicate that there are clear and strong regional influences on the location of foreign-owned enterprises in Britain. The cluster variables proxying

Marshallian externalities emerge as being somewhat more influential than those which proxy urbanisation externalities. The location quotient and its square are highly significant and the coefficients indicate an inverted-U relationship which is intuitively reasonable. The variables for the scale of own industry employment are less significant, with the squared term falling just outside conventional significance ($p=0.159$). The coefficients on this variable again take somewhat implausible signs implying an exponentially increasing relationship, but do once more imply a critical mass. As regards the variables capturing urbanization economies, the size of the regional economy is not significant. The diversity of the region's economy, however, is highly significant and the negative coefficient supports Jacobs (1985) argument that more diverse city regions display greater innovation and growth. There is also evidence of important regional fixed effects, particularly associated with the attraction of London, unsurprising given its status as one of the very top tier of world cities (Taylor *et al.*, 2003) and to a lesser extent the South East. The positive coefficients on Wales and Scotland (Scotland is just outside conventional significance, $p = 0.107$) may reflect their status as nations and development policies which have included attempts to attract inward investment.

Table 2: Logit regression for probability of company being foreign owned

Variable	Company being foreign owned			
	Coefficient	Z	Marginal effect	
Size	1.0055	37.63	0.0086	***
Size squared	-0.0333	-9.12	-0.0003	***
Age	-0.0434	-12.32	-0.0004	***
Age squared	0.0006	6.15	0.000004	***
Location quotient	0.6364	14.29	0.0055	***
Location quotient squared	-0.0673	-7.96	-0.0006	***
Total regional employment	-0.00000001	-0.24	$-8.8 * e^{-11}$	
Total regional employment squared	$17.75 * e^{-11}$	0.48	$6.65 * e^{-18}$	
Total own industry employment	-0.1998	-2.53	-0.0017	**
Own industry employment squared	0.0060	1.41	0.00005	
Regional industry diversity	-50.92	-3.52	-0.4373	***
London location	1.0887	15.95	0.0143	***
South East location	0.6298	11.88	0.0068	***
Wales location	0.2783	3.07	0.0027	***
Scotland location	0.1101	1.61	0.0010	
Industry dummies	included			
N observations	546778			
Wald $\chi^2(55)$	Highly significant			
Pseudo- R^2	0.2438			

*** significant at 1% ** significant at 5% * significant at 10%

The firm specific variables age and size both emerge as highly significant. That foreign-owned companies should be older and larger than the general population of all firms in Britain is reasonable. Those established as greenfield investments would be expected to have a higher propensity to survive and grow than the typical domestic start-up company as they are able to draw on both the “ownership” advantages of their parents and financial resources. Those foreign-owned companies which have been acquired are plausibly companies which were deemed attractive based, among other things, on their track record, which would be associated with greater longevity and size than the average British firm. This will not be true in every case, yet may hold as a generalisation.

The propensity to be innovative

Having established that there are regional influences on multinational activity, and that some of these influences relate to clustering, the question which will be addressed in the following two sections is to what extent clustering and multinationality promote innovation. A prime motivation for the question is the finding of Johansson and Lööf (2008), based on CIS data for Sweden, that whilst some regions have a disproportionate share of innovative firms, it appears to be firm characteristics rather than location *per se* which are the most important drivers of firm innovation effort. Furthermore, they find that the highest propensity to be innovative arises among domestic MNEs as opposed to domestic unational firms or foreign MNEs.

The regional fixed effects dummies may appear surprising at first with every English region having a positive and significant coefficient relative to the reference category composed of London, Wales, Scotland and North of England. Wales and Scotland were not at all significant when included and the effect is principally driven by London. At its root is an industry composition effect. London has a comparatively high share of service companies compared to the rest of Britain, whereas innovation activity is biased towards manufacturing industry. Simple χ^2 tests indicate that London has a significantly lower share of manufacturing firms, produces significantly fewer goods innovations, but significantly more service innovations. This gives a clue as to why the results obtained here differ directly from those obtained by Johansson and Lööf (2008) for Sweden, where there was a higher propensity for firms located in the Stockholm region to be innovative.

Table 3: Logit model of propensity to be innovative

Variable	Propensity to be innovative			
	Coefficient	Z	Marginal effect	
Size	0.3993	4.61	0.0772	***
Size squared	-0.0289	-2.82	-0.0056	***
Age	0.0076	2.35	0.0015	**
Location quotient	-0.0776	-2.07	-0.0150	**
Total regional employment	-3.31×10^{-9}	-0.35	-8.8×10^{-11}	
Total own industry employment	0.5487	3.34	0.1061	***
Own industry employment squared	-0.0325	-3.68	-0.0063	***
Regional industry diversity	73.45	2.34	14.20	**
North West location	0.3371	2.90	0.0608	***
Yorkshire location	0.4069	3.17	0.0723	***
East Midlands location	0.6312	4.03	0.1066	***
West Midlands location	0.3411	2.15	0.0614	**
East of England location	0.7241	3.57	0.1199	***
South East location	0.4719	3.53	0.0827	***
South West location	0.3069	3.00	0.0557	***
UK Multinational	0.2134	1.00	0.0392	
Foreign-owned company	0.0451	0.51	0.0086	
Market global	0.8202	10.23	0.1403	***
Market Europe	-1.0675	-17.81	-0.2311	***
Market UK	0.3553	6.00	0.0662	***
Human capital intensity	0.2362	8.46	0.0457	***
Firm established in the last 3 years	0.2701	2.20	0.0491	**
Firm in M&A in last 3 years	1.0205	7.42	0.1534	***
Innovative in previous CIS	0.6846	13.26	0.1247	***
Gross productivity	-0.00001	-2.90	-2.12×10^{-6}	***
Industry dummies	included			
N observations	11775			
Wald $\chi^2(34)$	1504.31	***		
Pseudo-R ²	0.1350			

*** significant at 1% ** significant at 5% * significant at 10%

The results obtained for the regional clustering variables are not clear cut. Employment in the firm's own line of industry in the region is highly significant and the coefficients indicate a plausible inverted-U relationship. The scale of the cluster matters. The coefficient on the location quotient (the square was not significant, therefore not included) is negative and significant, which is contrary to expectation, however Beaudry and Schiffauerova (2009) report that negative coefficients on the location quotient are more frequent in the literature than on own employment (though no explanation is offered regarding why). Taken together, therefore, the own industry effects are somewhat ambiguous. The results for the two variables proxying urbanization economies are both contrary to expectation. The coefficient on regional size is negative

and insignificant, whereas that on regional diversity is positive and significant, which is counter-intuitive as a higher value of the variable implies a more specialised region. It may be that this is here capturing some of the own industry influence which might otherwise be captured by the location quotient. It is, however, directly contrary to the theory associated with Jacobs.

The coefficients on the two multinational dummies are positive as expected, but neither is significant, whereas Johansson and Löf (2008) found that being a multinational was positively and significantly associated with being innovative. This model includes additional regional clustering variables, not included in Johansson and Löf, which are themselves associated with the likelihood of being multinational and this may in part explain the weaker effect of multinationality here. What is noticeable in particular is the relatively large and highly significant positive coefficient on the dummy for selling in global markets, which captures an alternative facet of success in international business. Less easy to explain is the negative coefficient on selling in Europe.

One possible explanation for some of the counter-intuitive results is that the definition of being innovative here is a widely-encompassing one, including attempts at innovation, even if no innovation output has been achieved, and treating relatively minor innovations as equal to more significant ones. To explore this, some auxiliary regressions were run, not reported in full in this paper. In a model considering only producing a goods innovation as innovation, both MNE dummies are positive and significant, with that on UK multinationals being the larger of the two. When considering major innovations, producing a goods, service or process innovation which is new to the market, the coefficients on both the multinational dummies are again positive, but only that on *foreign* multinationals is significant.

Many other firm attributes are in line with expectation. Size and age are both significant. Qualifying the effect of age is the evidence that newly established firms are also significantly associated with being innovative. Human capital intensity and a record of continuous innovation are both positive and highly significant, in line with expectation. Most industry dummies were positive and significant, indicating clear industry effects, which were strongest in SICs 24-27, which encompass chemicals, pharmaceuticals, rubber and plastics, manufacture of non-metallic mineral products and manufacture of basic metals.

The extent of innovation effort

Table 4: Heckman two-step model of R&D intensity

Variable	Coefficient	Z	
Size	-0.5358	-5.76	***
Size squared	0.0207	1.88	*
Age	-0.0020	-0.73	
Location quotient	0.3225	4.43	***
Location quotient squared	-0.0382	-3.18	***
Total regional employment	-5.83*e ⁻⁹	-0.71	
Total own industry employment	0.8441	5.90	***
Own industry employment squared	-0.0560	-7.04	***
Regional industry diversity	-383.94	-6.20	***
North West location	-0.7099	-5.09	***
Yorkshire location	-1.0101	-6.13	***
East Midlands location	-1.4393	-6.46	***
West Midlands location	-1.4143	-6.07	***
East of England location	-0.9784	-4.42	***
South East location	-0.8302	-4.33	***
South West location	-0.4845	-4.51	***
Wales location	0.8126	4.61	***
Scotland location	0.4057	3.66	***
UK Multinational	0.6397	4.37	***
Foreign-owned firm	0.5805	7.69	***
Firm produced process innovation	0.8708	18.45	***
Firm uses trademark to protect innovation	0.3367	5.73	***
Firm uses patents to protect innovation	0.3613	5.25	***
Firm involved in M&A in last 3 years	0.1493	1.91	*
Innovation in previous CIS	0.1829	4.41	***
Industry dummies	included		
Selection model	included		
Rho	-0.5391		
Sigma	1.7800		
Lambda	-0.9703		
N observations	12145		
Censored obs.	4931		
Uncensored obs.	7214		
Wald $\chi^2(34)$	1350.70	***	
Wald test of independent equations $\chi^2(1)$	101.14	***	

*** significant at 1% ** significant at 5% * significant at 10%

Included in the selection model: size, size², gross productivity, firm newly established, human capital intensity, market global, market Europe, market UK, industry dummies

In explaining the level of R&D intensity, the regional cluster variables capturing own industry effects, location quotient and own industry employment are both highly significant and have an inverted-U form. Only one of the variables proxying urbanization economies, regional diversity, is significant. This takes its expected

negative sign, indicating that greater diversity promotes innovation effort. The scale variable for urbanization economies, total regional employment, is negative and far from being significant. The dummies for the English regions now take a negative sign and are all highly significant, implying that those firms which are based in London engage in higher levels of innovation effort. This is consistent with the view that London has a special status as a premier world city and it has a privileged position as a centre of international flows on knowledge, personnel and financial resources, all of which may support innovation. Wales and Scotland have positive and significant coefficients, which may by extension reflect the fact they are separate nations with their own capital cities, albeit that they are on a much smaller scale than London.

When it comes to the scale of innovation effort, as opposed to the cruder 1,0 innovation dummy in the previous section, the coefficients on the two MNE dummies are now positive and highly significant, again after controlling for factors such as size and age. This supports the idea that MNEs may be distinguished from other firms by the superiority of their innovation effort. There is very little difference in the size of the coefficients for the UK MNEs and the foreign-owned firms. As may be expected, the dummies which capture past innovation effort, being classed as innovative in the previous CIS and having introduced a process innovation are both positive and highly significant, as are the dummies for use of trademarks or patents to protect innovations. Again there were some significant industry effects.

5. DISCUSSION

The results obtained are broadly consistent with the thrust of the literature. Stronger clusters do appear to promote ODI. These findings support Porter's (1990) contention about the positive effects of location in a strong cluster for success in international competition for *domestic* firms. Subsidiaries of overseas MNEs, all else equal, are more likely to be found in stronger clusters and also engage in higher levels of R&D effort than unination domestic enterprises. This fits with the general tenor of the results in the IB literature which have tended to focus on the benefits for overseas MNEs of locating in a strong overseas cluster and supports Enright's (2000) position that domestic clusters do not uniquely privilege domestic firms. Once domestic firms take the step of becoming MNEs, then they appear to be neither advantaged nor disadvantaged by their location relative to the subsidiaries of overseas MNEs. There is evidence in both sets of models

that both Marshallian localisation economies and “Jacobs” urbanization economies are important. It is, however, the former, based on within industry effects, which appear to be relatively more important. What the location quotient proxies is some underlying cluster processes associated with collocation in an industry, suggesting that there are unobserved factors, for which the location quotient is a proxy, such as density and intensity of firm interactions (Glaeser *et al.*, 1992) which are supporting cluster growth.

The differing influence of the four clustering variables, and how their influence alters depending on the nature of the dependent variable, can be considered in the context of the ongoing debate regarding the relative importance of Marshallian localisation economies and Jacobs urbanisation economies. Beaudry and Schiffauerova’s (2009) survey of the literature provides some useful stylised facts against which the results obtained in this paper may be compared, the measures used here being by far the most frequently employed in the literature. This paper has worked at the 3-digit industry level, which Beaudry and Schiffauerova identify as being neither disposed towards finding stronger localisation economies than urbanization economies or the opposite, therefore the tenor of our results, that localisation economies exert a somewhat stronger influence on both FDI and innovation, is unlikely to be an artefact of the level of aggregation used. Beaudry and Schiffauerova find that more disaggregated geographical scales tend to pick up stronger localisation and urbanization effects. The geographic unit used in this study is at the highly aggregated end of the spectrum, which if anything would bias our estimates downwards. Beaudry and Schiffauerova find that, in general, results are broadly comparable across countries, with some important exceptions. Studies of the UK are more disposed towards finding evidence of localisation economies, as is the case here. In terms of dependent variables, foreign direct investment and innovation both appear to be more associated with localisation economies, which is consistent with the results obtained here.

The generally positive coefficients on size and age are intuitively reasonable, both in terms of the IB literature and the broader literature of economics and strategy. Size may be associated with the possession of resource strengths (Barney, 1991) which enable the firm to grow. This sits comfortably with the increasing importance of the resource-based view for explaining firm success in the IB literature (Peng, 2001), albeit that a lot is being read into weak proxies for resource strength here. Size may also be associated with the ability to realise economies of scale and scope, though there is no direct evidence for either of these two effects. Similarly age may proxy accumulated

experience and therefore, up to a point, increases the chances of becoming multinational. Longer established firms will acquire greater experience in conducting overseas business, specifically cited by Dunning (1993) as an important ownership advantage.

The results obtained here have thrown up some puzzles, particularly in the light of comparison with very similar models estimated for Sweden by Johansson and Lööf (2008), who estimate highly similar models based on the CIS for Sweden. Firstly, they find unambiguous evidence that domestic MNEs produce higher levels of R&D intensity compared to overseas multinationals and unination domestic enterprises. This superiority of domestic MNEs is not observed here. Secondly, Johansson and Lööf find that regional influences on R&D intensity are not significant, being dominated by firm-specific characteristics. These results find both regional effects and firm-specific effects to be important for innovation effort. Moreover there is a particular fixed effect for London for which there is no counterpart in Stockholm. There are possible explanations which deserve further exploration. The first may be an industry composition effect, which would be supported if London were more specialised on services than Stockholm. Secondly, London is a more significant world city than Stockholm and therefore may play a critical role in the strategy formation of major multinational companies as suggested by Amin and Thrift (1992) and may also be privileged as being on the “superhighway” of knowledge, resource and human capital flows. Thirdly, Swedish domestic MNEs have a very high propensity to be internationalised and this may underlie their strong performance in innovation.

6. CONCLUSIONS

This paper has answered the two questions posed in the introduction in the affirmative. There is a growing body of theory which articulates why location in strong agglomerations may be especially beneficial for MNEs. It has also provided evidence that agglomeration economies are important in both promoting ODI and attracting IDI. Overall, within-industry clustering effects are more important than broader urbanisation economies. This concurs with Bronzini’s (2007) similar finding for Italy. The IB literature needs to be more careful to distinguish between these two effects, which imply different processes whereby firms build capabilities and resource strengths. Size and age were also found to be positively related to FDI, as would be expected. The general importance of the scale of own industry employment and human capital accords with the literature (Autant-Bernard, 2001; Erken and Kleijn, 2010). The importance of the

sectoral composition of a region in mediating regional innovation performance gibes with a similar finding using the Community Innovation Survey by Evangelista *et al.* (2001).

The results regarding the linkages between clustering and innovation, particularly as it affects multinational firms, were a little more ambiguous. The logit model of propensity to engage in innovation did indicate that own industry cluster scale is a positive and significant influence with a plausible inverted-U relationship indicating diminishing returns as the cluster grows. The relative own industry variable, the location quotient, however took a negative sign, contrary to expectation. The proxies for Jacobs urbanisation economies failed to manifest a significant positive influence, neither did the dummies for being multinational. When a stiffer criterion is applied, the influence of both clustering and multinationality come more to the fore. Both the scale and relative measures of localisation economies are highly significant and take a plausible inverted-U in explaining the level of R&D intensity. Regional diversity, proxying Jacobs externalities, is negative and significant as expected. Multinationals, both domestic and overseas, are significantly more likely to engage in higher levels of R&D.

The current study suffers from some important limitations. It would be desirable to incorporate a wider range of controls for differences in regional characteristics, the regional fixed effects dummies being crude proxies for what may be multifarious sources of regional advantage or disadvantage. The econometrics afford no insight into the strategic orientation of firms, nor how firms create and leverage advantages from locating within strong clusters and the empirical proxies for resource strength were weak. The study has taken no account of the length of time over which firms established their R&D operations in a particular cluster, even though it is clear that firms cannot absorb and take advantage of new knowledge instantaneously (Jenkins and Tallman, 2010). The results here do not control for overseas facilities which were established for either home-base exploiting or augmenting motives, which may confound some of the effect of the regional variables, since exploiting motives tend to be more strongly associated with locations closer to existing production or customers, whereas augmenting motives show a much closer association with “magnet” institutions such as universities (Ambos, 2005; Kuemmerle, 1999).

Some basic practitioner and policy implications flow, although, given the limitations of the study, they are expressed with due caution. The importance of agglomeration effects as an influence on international activity is supportive of the idea in

policy circles that cluster promotion may be a fruitful strategy. Policy thinking has been strongly influenced by the idea of flexible specialisation where clusters are composed of agile and highly-networked small and medium-sized enterprises, exemplified by the Third Italy and Baden Wurttemberg. There have been criticisms of the flexible specialisation model. Firstly, that it is not an accurate representation even of Baden Wurttemberg and the Third Italy (Malmberg & Maskell, 2002). Secondly, that this type of concentration is not the most common and that other types exist which also have a distinct rationale (Gordon & McCann, 2000; Markusen, 1996). In this study, multinationals, both domestic and overseas, emerge as important hub firms which are central to the dynamism of regional clusters, but largely absent from the dominant policy view of clusters. One important caveat is that of Cheshire and Gordon (1998) who argue that footloose firms are adept at capturing for themselves the benefit is incentives to tempt them in to particular regions and that the returns to investing in the promotion and retention of local firms may be much greater.

For practitioners there are two simple implications. Firstly, access to agglomeration economies is a relevant element in the location decision, although benefitting from such economies is not automatic and requires competence and effort. Secondly, the problems of congestion in major clusters mean a critical view needs to be taken of which activities are best placed or retained within a particular cluster. Knowledge generated in “external” clusters may be particularly difficult to disseminate within the MNE as it requires translation from the cognitive frame of reference of the locality to that of the firm (Foss and Pedersen, 2002). Moreover, as Jenkins and Tallman (2010) conclude, the costs of such a knowledge-seeking strategy are apt to be high and the benefits uncertain.

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