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Bournakis, Ioannis and Papanastassiou, Marina and Pitelis, Christos

Middlesex University, Business School, Middlesex University, Business School, Brunel University, Business School

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Ioannis Bournakis[1]

Marina Papanastasiou[2]

Christos Pitelis[3]

Abstract

This paper explores the relative effects of Multinational Enterprises' (MNEs) subsidiaries to domestic firms (DOMS) on regional productivity growth in the UK. We combine regional and firm level data to explore the relative importance of three key characteristics of Multinational Enterprises' subsidiaries: R&D, intangible assets and exports. Our main results indicate that MNE subsidiaries are on average more R&D intensive and have a higher level of investment in intangibles which impact significantly on regional productivity growth. The results are shown not to be symmetric when we take into account the country of origin of MNE subsidiaries, the role of R&D, intangibles and exports depending on the country of origin of the parental MNE. Two key implications can be derived from our findings: (a) DOMS can sometimes be more advantageous for local development; (b) the contribution of MNEs subsidiaries to the regional economy depends on its degree of embeddedness in the local economy. These two findings can provide a large scope for regional policy making.

Keywords: Total Factor Productivity (TFP), Regions, Multinationals, Subsidiaries, Domestic Firms, R&D, Intangibles, Exports.

JEL Classification: O47, R3, F23

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[1] Middlesex Business School, Department of Economics, Email: I.Bournakis@mdx.ac.uk

[2] Middlesex Business School, Department of International Management and Innovation, Email: M.Papanastasiou@mdx.ac.uk

[3] Brunel Business School, College of Business Arts and Social Sciences, Email:chris.pitelis@brunel.ac.uk

1. Introduction

The UK has historically been one of the leading host countries in terms of inward Foreign Direct Investment (FDI) (Dunning, 1958). Recent data show that around 45,000 affiliates are operating in the UK (Driffield et al., 2013) which amounts to circa 2% of total businesses, yet they account for 38-45% of total business R&D, 9% of total exports and 29% of total value added during the period 1997-2010 (WIR, 2012).

Inward FDI in the UK has not been equally distributed across regions, thereby potentially contributing to regional disparities which have been substantial and persistent (Rice and Venables, 2003; Dimitratos et al., 2009). While there is extensive literature on productivity differences between MNEs and DOMs (Lee and Kwok, 1988) and their associated spillovers at the aggregate and regional level in the UK (Blomström, and Kokko, 1996; Barrel and Pain, 1997; Blomström, and Sjöholm, 1999; Driffield and Hughes, 2003; Devereux et al., 2007; Girma and Wakelin, 2007), there is limited evidence on the relative impact of MNEs on regional productivity growth and convergence in the UK.

This paper aims to fill this gap by investigating the impact of MNE subsidiaries relative to DOMs in the UK within a regional productivity convergence framework over the period 2004-2010. The paper's central contribution to the existing literature takes two forms: firstly, the analytical framework used allows us to investigate the effect of MNEs' subsidiaries in a more dynamic context than has yet been done (Perkmann, 2006: Lin et al. 2011). More precisely, the empirical model considers regional Total Factor Productivity (TFP) growth as a function of relative MNEs' characteristics that also drive the convergence process between productivity laggard regions and the national frontier. The implementation of this strategy requires a combination of regional and firm level data, which is a challenging task by itself; nonetheless, empirically, it is the most appropriate method[4] as it allows us to identify directly the impact of MNEs on local economies using structural firm-level information of R&D, intangible assets and exports.

The second contribution of the paper is to identify effects associated with the country of origin of the MNEs. To do so, we disintegrate the sample of MNE subsidiaries into four major investor groups namely, US, EU, Japan and the Rest of World. We hypothesize that this classification can unearth country-specific effects of MNE subsidiaries. If so, that could allow for a more fine-tuned approach to regional policy making.[5] Finally, our analytical approach cross-fertilizes strands of the productivity and international business (IB) literature to enrich the very limited evidence on the underlying forces of the substantial regional disparities in the UK (Driffield et al., 2013, p.14).

The rest of the paper is organized as follows: section two provides the literature review and hypotheses formulation, section three presents an analytical framework on convergence, the data and methodology, section four presents and discusses our results including our econometric sensitivity analysis and section five concludes.

2. Literature Review and Hypotheses Development

The presence of MNEs in the local economy generates direct and indirect effects; the former group refers to employment opportunities generated from the business activities of MNEs in the local market while the latter include mainly spillover effects from technology and

[4] See Criscuolo and Martin (2009) for a discussion concerning identification issues of MNCs and local firms in the UK.

[5] See Buckley, Clegg and Wang, 2007 for a similar argument.

knowledge transfer. Focusing on the set of indirect effects, the performance and impact of MNE affiliates is often benchmarked against that of DOMs. Chung et al. (2003) find that Japanese FDI in the US automotive industry improves productivity of US-based suppliers; this can result either from collaboration between MNE subsidiaries and DOMs or from increased competition between these two groups of firms. Benito et al. (2003, p 445) argue that FDI-induced effects in high value added activities are maximized for the host economy when MNEs tend to be "sticky", particularly in terms of the degree of embeddedness between MNEs and local suppliers.

New trade theory (Markusen and Venables, 1998) and endogenous growth models (Aghion and Howitt, 1998) show how MNEs can contribute to the growth of the host economies through transfer of intangible assets such as technological know-how (Barrell and Pain, 1999). Badinger and Tondl (2005) and Dettori et al. (2012) - among many others - provide empirical evidence regarding the positive effect of trade openness, intangible assets (in the form of human, social and technological capital) and innovation on regional growth in Europe in the 1990s.

In IB, Dunning's (1993) Ownership, Location, Internalization (OLI) framework, identifies two main types of ownership advantages that help foreign affiliates compete successfully in host countries: (a) possession of intangible assets and (b) the ability of the firm to coordinate its assets and activities. The first set of advantages are known as asset ownership advantages (*Oas*) and include knowledge expertise and innovation superiority of MNEs, while the second set of advantages is governance- related and refers mainly to "transaction cost minimizing advantages" (*Ots*) (Dunning, 1993, p. 80). Both types of advantages are strongly associated with multinationality. Accordingly, MNE subsidiaries are often assumed to outperform DOMs on the basis of *Oas* and *Ots* (Hymer, 1976; Zaheer, 1995; Johanson and Vahlne, 2009).

Turning to R&D, the most representative *Oas* (Dunning and Lundan, 2008), a widely accepted stylized fact is that MNE subsidiaries are more research intensive than DOMs (Markusen, 1995). R&D is traditionally perceived as a centralized strategic activity of MNEs. Nonetheless, Papanastassiou and Pearce (2009) acknowledge that the current trend is a shift of global innovation activities towards MNEs subsidiaries that increasingly become major players in generating intangible assets and new knowledge (Feinberg and Gupta, 2004; Almeida and Phene, 2004; Griffith et al., 2004). On the above basis, our baseline Hypothesis (H) is that:

H1: The relative impact of R&D activity of MNE subsidiaries to that of DOMs on regional growth is positive and significant.

Apart from R&D, Dunning (1993) identified other forms of *Oas*, including knowledge capital, product differentiation and marketing capabilities. Denekamp (1995) showed that the possession of intangible assets provides a major advantage for firms to engage in outward FDI and thus overcome the "*liability of foreignness*" (Zaheer, 1995; Anand and Delios, 1997). These considerations motivate our second Hypothesis.

H2: The relative impact of intangible assets of MNE subsidiaries to those of DOMs on regional growth is positive and significant.

MNE subsidiaries undertake a variety of roles that can affect MNE's productive potential and can also improve the local economy's productive capacity (Andersson et al., 2002; Meyer, et al, 2011). In general, MNE subsidiaries are expected to be highly exportoriented as they get involved with global intra-firm transactions (Kumar, 1994). Exporting activity embodies substantial learning effects both for the host and the origin country (Dunning, 1993; Greenaway et al., 2004). The export linkages of MNE subsidiaries can help create knowledge spillovers that are likely to foster international competitiveness and export intensity of their domestic counterparts too (Keller and Yeaple, 2009). Certainly, the latter effect is always subject to an empirical verification as it mainly depends on DOMs ability to absorb effectively the exporting experience of others. Overall, export orientation of MNE subsidiaries is expected to bring positive spillovers that impact substantially on the growth potential of local regions. These considerations lead us to the third hypothesis tested in the paper:

H3: The impact of export activity of MNE subsidiaries relative to that of DOMs on regional growth is positive and significant.

Cohen and Levinthal (1990) emphasized the interactive and dynamic interdependence between firms and locations in the context of the notion of 'absorptive capacity' (Griffith, et al., 2003). Håkanson and Nobel (2001) highlighted the importance of "*embeddedness*" between subsidiaries and local economies in order for the latter to capture FDI related gains. Conditions to "embeddedness" between local regions and MNEs include, among other factors, intra-firm R&D activities, entrepreneurial subsidiaries, distant global markets and global production networks.[6] One can infer from the above that the convergence process of laggard regions depends on the presence of MNE subsidiaries. Gains from R&D intensity, export orientation and intangible assets of MNE subsidiaries are likely to be more pronounced for those regions that fall behind in productivity terms. Girma (2005) and Haskel et al (2007) highlighted that FDI-related gains can be sustainable subject to two conditions: (a) there must be adequate embeddedness of the MNE subsidiaries into the local economy and (b) local regions must have enough absorptive capacity to capture effectively MNEs'-induced spillovers. In the absence of the above conditions FDI only brings temporary gains without long run growth effects. To summarize the previous discussion, convergence gains for UK laggard regions are more likely to be implemented if MNE subsidiaries are embedded into the local economy. The fourth hypothesis of the paper is accordingly formulated as:

H4: The relative impact of MNE subsidiaries to DOMs in the convergence process of productivity of laggard region is positive and significant.

Buckley et al. (2002) argued that the nationality of MNC is a major determinant of the potential FDI effect on regional growth. Griffith (1999) and Criscuolo and Martin (2009) revealed the superiority of R&D activity undertaken from USA subsidiaries. Gelübcke (2013) investigated the impact of parent country heterogeneity of various foreign affiliates operating in Germany. His study showed that subsidiaries from different countries of origin have different business strategies, which can help explain the contribution of foreign firms to the local economy[7]. Based on this evidence, we seek to explore whether there is an MNE subsidiary nationality effect in regional growth in the UK. The fifth hypothesis of the paper is then formulated as:

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[6] See Coe et al. 2004, Table 1, p. 471

[7] See Frenz and Ietto-Gillies (2007) for a detailed analysis on the distinction between *multinationality* and *foreignness*

H5: The impact of MNE subsidiaries activities on regional growth varies by country of origin of the parent company.

3. Analytical framework: Methodology, Measurement Issues

3.1 Methodology

In order to test the five hypotheses developed in the previous section, we first model productivity in region *j* as follows:

$$A_j \equiv TFP_j = f(R_i, IK_i, X_i) \quad (1)$$

Equation (1) states that TFP (the productivity parameter *A*) in region *j* is a function of the following characteristics (*c*): R&D activity (R), intangible capital (IK) and export activity (X) of firms, indexed with *i*. Based on the discussion in section 2, these firm characteristics create regional knowledge spillovers that potentially boost region *j*'s productivity growth. In specifying an empirical version of equation (1), we employ a convergence formulation (Griffith et al., 2009) that models parameter *A* as a function of its lagged by one period level ($A_{j,t-1}$), a term ($A_{F,t}$) of convergence between region *j* and the frontier *F* and a factor γ_i^c that include firm structural characteristics crucial for region *j*'s technological capabilities:

$$\ln A_{j,t} = \ln A_{j,t-1} + \lambda \ln\left(\frac{A_{F,t}}{A_{j,t}}\right) + \sum_{c=R,IK,X} \gamma^c_{j,i,t} + u_{j,t} \quad (2)$$

Taking parameter *A* and the convergence term in logs and adding an error stochastic term *u*, we obtain the benchmark specification for our empirical analysis. We further re-arrange (2) by taking the lagged value of *A* onto the left-hand side and reach the following equation of the growth rate of *A* (i.e. TFP growth) in region *j*.

$$\ln \Delta A_{j,t} = \lambda \ln\left(\frac{A_{F,t-1}}{A_{j,t-1}}\right) + \sum_{c=R,IK,X} \gamma^c_{j,i,t} + u_{j,t} \quad (3)$$

where, λ is a parameter to be estimated and stands for the speed of productivity convergence between region *j* and its frontier counterpart *F*. We expect the estimated coefficient of λ to be positive confirming the proposition that the larger the gap between *j* and *F* the faster the productivity growth rate for *j* (Harris, 2011).

Factor γ_i^c in equation (3) includes the three firm characteristics displayed in function (1). These MNE subsidiaries' (M) characteristics are expressed relative to DOMS (D)[8] located in region *j*. Therefore, we decompose (3) for all firm characteristics as:

$$\ln \Delta A_{j,t} = \lambda \ln\left(\frac{A_{F,t-1}}{A_{j,t-1}}\right) + \beta_1 \frac{R_{j,M,t}}{R_{j,D,t}} + \beta_2 \frac{IK_{j,M,t}}{IK_{j,D,t}} + \beta_3 \frac{X_{j,M,t}}{X_{j,D,t}} + u_{j,t} \quad (4)$$

where parameters β are to be estimated and capture the impact of relative firm characteristics on regional growth.

[8] In the empirical implementation we exclude domestic multinationals focusing only on firms with zero foreign subsidiaries.

As the central goal of the paper is to assess the role of MNE subsidiaries relative to DOMs on regional growth, we augment (4) with an interaction term. This term tests essentially whether regions accelerate convergence by absorbing more effectively the spillovers generated from each of these firm activities. The specification with the interaction convergence term is written as:

$$\ln \Delta A_{j,t} = \lambda \ln\left(\frac{A_{F,t-1}}{A_{j,t-1}}\right) + \beta_1 \frac{R_{M,j,t}}{R_{D,j,t}} + \beta_2 \frac{IK_{M,j,t}}{IK_{D,j,t}} + \beta_3 \frac{X_{M,j,t}}{X_{D,j,t}} + \sum_{c=R,IK,X} \rho^c \gamma^c_{i,j,t} \times \ln\left(\frac{A_{F,t-1}}{A_{j,t-1}}\right) + u_{j,t} \qquad (5)$$

where parameter ρ^c to be estimated measures the responsiveness of TFP growth in region *j* with respect to firm characteristic *c*. Intuitively, the estimated coefficient for ρ captures which firm characteristics are important to closing the gap between regions falling behind and the frontier (Griffith et al., 2003)[9].

3.2 Measurement and Data Issues

3.2.1 Regional TFP Growth Index

To assess empirically equations (4) and (5), we use two different data sources. First, we gather data from Office of National Statistics (ONS) to calculate regional TFP. These data are taken from regional accounts and refer to Nomenclature of Territorial Units of Statistics (NUTS level 2 aggregation).[10] Second, we construct firm level characteristics represented in γ^c from FAME data base (2012) (Bureau Van Dijk).

We proceed first with the computation of TFP, which is itself a challenging task. TFP is constructed using the approach of Caves et al. (1982a, 1982b). We employ a translog production function based on the assumption that there are constant returns to scale in regional production. This formulation follows an influential line of research (see Lucas and Rossi-Hansberg, 2002 and Combes et al. 2008) which hypothesize that any positive spillovers are external to the region itself. This formulation also assumes that any potential positive effect from the presence of MNE subsidiaries, impact on regional productivity in a Hicks–neutral way (all regional factors of production are affected symmetrically). Additionally, we account in our TFP calculations for the presence of imperfect competition in the regional market by adjusting input shares for price mark ups (Roeger, 1995) (see Appendix A1).

The index of TFP growth (TFPG) in region *j* is computed as:

$$\text{TFPG}_{j,t} = \ln\left(\frac{Y_{j,t}}{Y_{j,t-1}}\right) - \alpha^L_{j,t} \ln\left(\frac{L_{j,t}}{L_{j,t-1}}\right) - (1-\alpha^L_{j,t}) \ln\left(\frac{K_{j,t}}{K_{j,t-1}}\right) \qquad (6)$$

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[9] We expect the sign of ρ to be positive given that the superior characteristics of MNEs will be more beneficial for laggard regions in closing the gap toward the frontier.

[10] The full list of NUTS Level 2 regions can be found in Table 1.

Output Y is measured by Gross Value Added (GVA) in region j, L is the labour input currently defined as the number of employees[11] and K denotes the capital stock. We initially define labour share α as the ratio of labour compensation to value added and enters equation (5) in a weighted manner as: $\alpha^L_{j,t} = \frac{\alpha_{j,t} + \alpha_{j,t-1}}{2}$. We then adjust factor share α for a measure that captures the presence of market power. Market power is represented with a mark-up index computed with the Hall (1988, 1991) and Roeger (1995) approach (See Appendix A1 for further details). [12]

Turning to the measurement of other variables in the TFP growth index, we convert GVA into 1995 GBP constant prices using industry value added (Nomenclature Statistique des Activités Economiques dans la Communauté Européenne (NACE Rev. 2) whereas deflators are taken from Office of National Statistics ONS. Labour compensation data are expressed into 1995 GBP constant prices using unit labour cost indices (OECD STAN (2010)). Capital stock (K) is generated from the perpetual inventory method:

$$K_{j,t} = K_{j,t-1} - \delta K_{j,t-1} + I_{j,t-1} \tag{7}$$

where δ is the physical depreciation rate, defined at the constant rate of 10% for all regions j. Investment (I) is measured by Gross fixed capital formation (GFCF) after converting values into 1995 GBP constant prices using capital price indices. We initiate the capital stock series with the following steady state identity: $K_{j,2000} \equiv \frac{I_{j,2000}}{g_j + \delta}$, where g is the average growth rate of regions j's investment over the whole period and year 2000 in the subscript indicates the first year with available investment data.[13] Therefore, the TFP growth measure adjusted for market power is rewritten as:

$$\text{TFPG}_{j,t} = \ln\left(\frac{Y_{j,t}}{Y_{j,t-1}}\right) - \tilde{\alpha}^L_{j,t} \ln\left(\frac{L_{j,t}}{L_{j,t-1}}\right) - (1 - \tilde{\alpha}^L_{j,t}) \ln\left(\frac{K_{j,t}}{K_{j,t-1}}\right) \tag{8}$$

where $\tilde{\alpha} = \mu\alpha$, with μ to denote the mark-up index.

3.2.2 Regional TFP Level Index

Levels of TFP are also needed for the calculation of the empirical counterpart of $\ln\left(\frac{A_{F,t-1}}{A_{j,t-1}}\right)$, which captures convergence at the regional level. The level of TFP in region j is calculated analogously with equation (8) using the approach of Caves et al. (1982a, 1982b).

[11] Admittedly, to measure labour as an aggregate input can cause measurements bias as not all workers have the same qualifications and characteristics. Ideally, labour input can be classified by the level of educational attainment but these data is not available at a regional level hence labour is introduced in our TFP measure as a homogenous input.

[12] See Appendix A, for a full illustration of the HR methodology and the construction of mark-ups.

[13] Although, regional data are available from 2000 onwards, the econometric analysis is restricted to the period 2004-2010, which basically dictated by the availability of firm level data. However, we prefer to use all data available for the construction of capital stock.

Nonetheless, for the TFP level we weight each observation with a reference point, denoted with an upper score bar as follows:

$$\text{TFP}_{j,t\text{-}1} = \ln\left(\frac{Y_{j,t-1}}{\bar{Y}_{F,t-1}}\right) - \alpha_{j,t}^{L} \ln\left(\frac{L_{j,t-1}}{\bar{L}_{F,t-1}}\right) - (1-\alpha_{j,t}^{L})\ln\left(\frac{K_{j,t-1}}{\bar{K}_{F,t-1}}\right) \tag{9}$$

The reference point is taken as the geometric average of the variable under consideration for the whole sample in each year. We can now define the convergence term (GAP) as follows:

$$GAP = TFP_{F,t-1} - TFP_{j,t-1} \tag{10}$$

where F stands- as already stated- for the frontier region, which is taken as the group of regions whose TFP level is placed in the top 5% percentile of the distribution in each year.

3.2.3 FAME Data

The paper endeavors to compare the relative performance of MNE subsidiaries and DOMs using firm level data from FAME Database (2012) (Bureau Van Dijk). We select firms from three broadly defined sectors: industry, services and retail trade. Two samples of firms are constructed, one for MNE subsidiaries and one for DOMs. For MNE subsidiaries, we use firms with at least one foreign shareholder that owns 50% (or above) while MNE subsidiaries are not allowed to have any domestic shareholder. While arguably stringent, this definition of MNE subsidiary has the advantage of clearly delineating and hence being able to assess the relative role of foreign versus domestic ownership.[14] According to this criterion, the number of MNEs in the UK is found to be 11,057 for the period 2004-2011.

For DOMs, two selection criteria are used: firstly, the ultimate owner must be of domestic origin and own 50% (or above) of the corporation and secondly the DOMs cannot be multinationals themselves. This is in order to strictly delineate domestic from multinational equivalent to Castellani and Zanfei's (2006) and Frenz and Ietto-Gillies (2007). In addition, in order to ensure that domestic firms are under a strictly defined domestic ownership, we exclude from the initial sample firms in which a minority share is registered to a foreign shareholder. After these adjustments, the total number of domestic firms is found to be 16,548 for the same period. The three firm characteristics used from FAME data are expressed in intensity forms. Specifically, we define them as:

$$R_i = \frac{\text{R\&D}_i}{\text{Worker}_i} \tag{11.1}$$

$$IK_i = \frac{\text{Intangible Assets}_i}{\text{Worker}_i} \tag{11.2}$$

$$X_i = \frac{\text{Exports}_i}{\text{Sales}_i} \tag{11.3}$$

Once we calculate these ratios for each firm i we then calculate the average of these ratios for each region j so as the analysis is conducted using information for the average MNE subsidiary and DOM in the region:

[14] See Gaur and Lu, 2007 for a similar definition.

$$\frac{1}{N}\sum_{n=1}^{N} x_{j,i,t} \qquad (11.4)$$

where N is the total number of firms for each group and x is the firm characteristic under question. Finally, we express the average intensity ratios of MNE subsidiaries relative to those of DOMs as already shown in equations (4) and (5). In this way we are measuring the *relative* strength of the *multinationality effect* that might result in the superior performance of MNE subsidiaries.[15]

3.3 Descriptive Statistics

Table 1 shows average values for TFP growth rates for the sample period, 2004-2011. The term distance is the exponential value of the inverse GAP term (i.e. $\exp\left(\frac{A_j}{A_F}\right)$) and shows the average distance of each region j from the frontier. This descriptive evidence shows that on average region j has 57% of TFP of the frontier region or in other words the gap from the frontier is 43%. The table shows large variations in the distance figures, implying that speed of convergence differs across regions; thus there is potential for laggard regions to grow. Most regions that lie closer to the frontier tend to have negative or zero growth rates. The last column of Table 1 shows TFP levels for those 36 regions. The group of regions with the highest level of TFP includes Inner London, Bedfordshire, Kent and Eastern Scotland while the group of regions at the bottom includes Staffordshire, East Anglia, East Yorkshire and Lancashire.

Table 2 shows mean values for R&D, exports and intangibles for MNE subsidiaries and DOMs. Indicatively, MNEs demonstrate higher levels in all these activities and it remains to be shown in the econometric analysis to follow whether this superiority of MNE subsidiaries is critical for regional growth (Görg and Strobl, 2001; Mariotti et al., 2014).

[Insert Table 1 Here]

[Insert Table 2 Here]

4. Econometric Results and Sensitivity Tests

Econometric specifications are presented in Table 3. Equation (4) is estimated for two different specifications and two different estimators. First we run regressions without the interaction terms between GAP and firms' specific characteristics; second, we use two different estimators to control for potential endogeneity. The benchmark estimator used in the paper is the within effects (WE) estimator while we also use a generalized methods of moments (GMM) estimator that controls for endogeneity in our model. The within fixed effects (WE) [16]estimator controls for heterogeneity in our panel structure by expressing all variables as deviations from their sample means. Additionally, the coefficients reported in Table 3 are robust and consistent for group-wise heteroscedasticity (i.e. $Var(u_{j,t}) \neq \sigma_j^2$) and

[15] See Mata and Freitas, 2012 and Hígon, and Antolín, 2012 for a more detailed discussion on this distinction.
[16] The WE estimator is equivalent to an OLS estimator with regional dummy variables.

cross-sectional correlation (i.e. $Cor(u_{j,t}u_{k,t}) \neq 0$ for any regions $j \neq k$). All variables enter the regressions lagged by one period. This is in order to capture the time needed for the manifestation of regional growth effects from the activities of subsidiaries and local firms. We have also experimented with contemporaneous values of firm level variables on the right-hand side as well as with two year lags and the results (which are available from the authors on request) are qualitative similar. Finally, all estimates shown in Table 3 include sector dummies.

The second estimator used is GMM, to control for the presence of endogeneity in our specifications. Our models (4) and (5) specify as dependent variable the rate of TFP growth in region *j* while the level of TFP is a component of the GAP variable. This implies that the growth rate depends on the initial level of productivity, which raises the concern whether the estimates shown in Table 3 are spurious. Another potential source of endogeneity bias can exist from the fact that firms with superior characteristics (i.e. in R&D activity, export performance and intangible capital) select to do business in more productive regions. In other words, one can argue that MNEs are likely to locate their activities in regions with faster growth. Those considerations suggest that the causation might also run from TFP growth to MNEs' characteristics, so we need an appropriate estimator to control for possible feedback effects between TFP growth rates and firm characteristics. The GMM[17] estimator addresses endogeneity using instruments for all potential endogenous variables. We consider all right hand side regressors as endogenous and replicate estimates using GMM.

The next step is to select appropriate instruments for GMM. Right instruments must be correlated with the endogenous variables while being uncorrelated with the error term in equation (4). We use higher order lags of the endogenous variables as instruments (i.e. $GAP_{j,t-2}$ and $GAP_{j,t-3}$) based on the information that our equations (4) and (5) are free of serial correlation in the residuals. We run an Arrelano and Bond (AB) test for serial correlation for up to three lags without being able to reject the null hypothesis of no-autocorrelation. This indicates that higher order lags of the endogenous variables are valid instruments. Results from GMM estimations are shown next to WE estimates in Table 3.

[17] The GMM estimator also controls for unobserved measurement bias in the construction of our variables. The current TFP measure corrects for the existence of imperfect competition with the use of price mark-ups but admittedly can there still be other source of measurement bias. For example, capital stock is a rigid factor and not always under full capacity utilisation. In cases that capital is not fully utilised, increases in TFP do not necessarily reflect technological progress but only improvements in the level of scale efficiency.

Table 3: TFP Growth in UK Regions and Firm Characteristics, 2004-2011

	WE	WE	GMM	GMM
GAP(t-1)	0.716***	0.918***	1.249***	1.495***
	(9.94)	(9.43)	(12.96)	(4.55)
R(t-1)	0.038*	-0.003	0.045**	0.124*
	(1.96)	(-0.11)	(1.98)	(1.93)
X(t-1)	-0.012	-0.032	-0.057	-0.005
	(-0.50)	(-0.91)	(-1.11)	(-0.06)
IK(t-1)	0.053***	0.116***	0.107***	0.138**
	(2.93)	(4.62)	(3.52)	(1.97)
Interaction Terms-MNCs Characteristics and Convergence				
[GAP×*R*](t-1)		0.050**		-0.140
		(1.98)		(-1.09)
[GAP×*X*](t-1)		-0.000		-0.054
		(-0.01)		(-0.36)
[GAP×*IK*](t-1)		-0.100***		-0.031
		(-2.95)		(-0.22)
Observations	391	391	261	254
Adjusted R^2	0.3150	0.3528	0.1361	-0.0497
F-statistic	33.730	41.379	51.256	8.334
Hansen Test			0.168/0.682	1.889/0.756
LM Test			51.07/0.000	16.084/0.007
AB(1)			-0.91/0.36	
AB(2)			-0.93/0.35	
AB(3)			1.05/0.29	

t statistics in parentheses with * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All three firm characteristics are expressed as ratios between intensity of MNCs and Domestic firms. GMM estimations instrument endogenous variables *GAP, R, X, IK, GAP×R, GAP×X, GAP×IK* with their values in periods t-2 and t-3. Hansen statistic refers to over-identification of restrictions in GMM. The joint null hypothesis is that the instruments used are valid, uncorrelated with the error term. Similarly LR statistic refers to under-identification of instruments; a rejection of the null indicates that excluded instruments irrelevant so equation is well identified. P-values are displayed next to the statistics.

As we observe, the GAP term is positive and statically significant in all specifications of Table (3) indicating convergence across UK regions. This suggests that the higher the productivity gap between any region and the frontier, the faster the laggard region tends to grow. Regarding the speed of convergence, the estimated coefficient of GAP, is ranked between 0.71-1.49 and it is slightly higher than the range of coefficients found in Griffith et al. (2004; 2009). The current coefficients are quite close to the results documented in LoPez-Bazo et al. (2006) for Spanish regions, highlighting the possibility that estimates about the speed of convergence may vary across econometrics specifications. More importantly, the estimated coefficient of GAP remains positive and statistically significant in the GMM estimation indicating that any endogeneity bias is not changing the importance of convergence in regional growth. Regarding our hypotheses, the coefficient of R&D intensity (*R*) is positive and statistically significant in three out of four specifications reflecting the relative stronger impact of MNC subsidiaries on TFP growth. This result confirms *H1* and complements the existing literature on the relative R&D strength of MNE subsidiaries (Cantwell and Mudambi, 2005; Barrios et al., 2003; Bae and Noh, 2001; Cantwell and Iammarino, 2000).

Our positive and significant coefficients for intangibles *(IK*) suggest that MNEs specific *Oas* are important in enhancing growth, confirming *H2*. This finding is compatible to Kramer et al., (2011) and Girma and Wakelin (2000), underlining the important role of MNE subsidiaries' organizational and managerial practices on local development.

With regard to export intensity *(X),* and contrary to our *H3*, the coefficients are negative but statistically insignificant. A potential interpretation of this result might be that DOMs develop export profiles which contribute more to regional TFP growth as compared to those of MNE subsidiaries, as these may be linked to wider MNE export grids without being adequately embedded in the regional economy[18].

Turning to the interaction terms and *H4*, the statistically positive coefficient of the GAP-R&D term, is consistent with previous studies (Griffith et al. 2003; Feinberg and Gupta, 2004). Our finding stresses that MNE subsidiaries are technologically superior to DOMs and this accelerates the speed of convergence for regions that are already falling behind. The statistically negative coefficient of the interaction term of GAP with intangibles, (*IK*) indicates that investment in intangibles from DOMs is more important for regional convergence. This result mainly highlights that the distance of organizational sophistication- as reflected in intangible assets- between DOMs and regional standards is closer and this impacts more effectively on convergence (Harris and Li, 2009; Liu, et al., 2000, Cummings and Teng, 2003).

To investigate whether the nationality of MNE subsidiaries matters and thus distinguish among different *origins of foreignness* (Frenz and Ietto-Gillies, 2007), we differentiate the sample of subsidiaries into four geographical sub-groups, namely to those with headquarters in EU, USA, Japan and the rest of the world (ROW). Then we estimate variants of our benchmark specifications (equations 4 and 5) including the origin of MNE subsidiary and run separate regressions for each firm characteristic as follows:

$$\Delta \ln TFP_{j,t} = \lambda \ln\left(\frac{A_{F,t-1}}{A_{j,t-1}}\right) + \sum_{origin=4} \beta_R^{origin} \frac{R_{j,t}^{origin}}{R_{j,D,t}} + \sum_{origin=4} \rho_R^{origin} \frac{R_{j,t}^{origin}}{R_{j,D,t}} \times \ln\left(\frac{A_{f,j,t}}{A_{i,c,t}}\right) + u_{j,t} \tag{12}$$

$$\Delta \ln TFP_{j,t} = \lambda \ln\left(\frac{A_{F,t-1}}{A_{j,t-1}}\right) + \sum_{origin=4} \beta_{IK}^{origin} \frac{IK_{j,t}^{origin}}{IK_{j,D,t}} + \sum_{origin=4} \rho_{IK}^{origin} \frac{IK_{j,t}^{origin}}{IK_{j,D,t}} \times \ln\left(\frac{A_{f,j,t}}{A_{i,c,t}}\right) + u_{j,t} \tag{13}$$

$$\Delta \ln TFP_{j,t} = \lambda \ln\left(\frac{A_{F,t-1}}{A_{j,t-1}}\right) + \sum_{origin=4} \beta_X^{origin} \frac{X_{j,t}^{origin}}{X_{j,D,t}} + \sum_{origin=4} \rho_X^{origin} \frac{X_{j,t}^{origin}}{X_{j,D,t}} \times \ln\left(\frac{A_{f,j,t}}{A_{i,c,t}}\right) + u_{j,t} \tag{14}$$

With origin=EU, USA, Japan, ROW

[18] Similar findings are documented in Phelps et al. (2003).

We estimate equations (11)-(13) with GMM to correct for endogeneity as per our previous discussion. Results are reported in Table 4. Results based on the country of origin reveal a more complex pattern. As far as R&D intensity is concerned, the negative and statistically significant coefficient of European MNEs over DOMs indicates the importance of local firms' R&D in driving TFP growth. On the other hand, USA MNEs' subsidiaries R&D dominate those of DOMs in regional growth. A potential explanation for the asymmetric effect between European and USA subsidiaries is that the latter group of subsidiaries might be more innovative thus spillovers from research activities can boost regional growth (Griffith, 1999). These results may reflect varying effects of what Caves (1974) identifies as a major category of benefits that can accrue to a host region the so-called *demonstration effect.* This effect highlights the efforts of the DOMs to acquire higher technological competencies due to the presence of MNEs in the market. A similar effect, labelled *technical efficiency* or *technology transfer*, shows the efforts of weak local firms to adopt more sophisticated technological resources in order to be able to compete with the more technologically advanced MNEs (pp.176-177).

Regarding export intensity, European MNE subsidiaries seem to contribute more to regional growth over DOMs whilst DOMs seem to be more export intensive compared to US and ROW MNEs. Temouri et al. (2008) in their investigation for TFP differences using firm level data for foreign MNEs, DOMs and German MNEs located in the different regions in Germany in manufacturing and services showed that East Germany regions have higher growth potential once Western German companies are operating there, reflecting as they state that "indigenous development may generate larger long term effects" (p.24).

Finally, Japanese subsidiaries are shown to be beneficial to regional growth as they bring into the local economy superior technological know-how and managerial expertise. Turning to the interaction terms in Table 4 what matters most for convergence in UK regions is the R&D of European MNEs and the Intangible Assets of Japanese MNEs.

To conclude, when we disintegrate the activities of MNEs there is evidence that DOMs can outperform subsidiaries from some MNEs from specific countries of origin. This finding contradicts some earlier studies that find MNE subsidiaries to be consistently superior to DOMs for regional growth (Blomström and Sjöholm, 1999). Having said this, our results support previous empirical findings (Cantwell and Iammarino, 2000; Ke and Lai, 2011; Altomonte and Pennings 2009) that place caveats regarding the *a priori* "superiority" of MNE subsidiaries on regional economic activity and thus on the strength of the *multinationality effec*t when the *origin of foreignness* is taken into consideration (Narula and Driffield, 2012). As Bode, et al., (2012) argue, whilst in the context of developing economies spillovers are expected to derive only from FDI, in the context of a developed economy both MNEs and DOMs may induce them.

Table 4: Sources of TFP Growth, Origins of MNC Subsidiaries

	GMM-Equation (12)	GMM- Equation (13)	GMM- Equation (14)
GAP(t-1)	1.345***	1.980***	1.285
	(6.41)	(5.91)	(0.97)
R-EU(t-1)	-4.807***		
	(-2.76)		
R-USA(t-1)	4.217***		
	(3.48)		
R-Japan(t-1)	-1.485		
	(-1.09)		
R-ROW(t-1)	1.637		
	(1.59)		
X-EU(t-1)		2.843**	
		(2.26)	
X-USA(t-1)		-0.404***	
		(-2.81)	
X-Japan(t-1)		0.213	
		(0.35)	
X-ROW(t-1)		-3.146**	
		(-2.08)	
IK-EU(t-1)			-0.496
			(-0.59)
IK-USA(t-1)			-0.646
			(-0.70)
IK-Japan(t-1)			3.720**
			(2.55)
IK-ROW(t-1)			-1.336
			(-1.20)
Interaction Term-Absorptive Capacity			
[GAP×*R* -EU](t-1)	4.687**		
	(2.06)		
[GAP×*R* -USA](t-1)	-3.266***		
	(-3.05)		
[GAP×*R* -Japan](t-1)	0.042		
	(0.03)		
[GAP×*R* -ROW](t-1)	-1.506		
	(-0.86)		
[GAP×*X*-EU](t-1)		-2.153	
		(-1.59)	
[GAP×*X*-USA](t-1)		0.088	
		(0.50)	
[GAP×*X*-Japan](t-1)		-0.679	
		(-1.29)	
[GAP×*X*-ROW](t-1)		2.337	
		(1.48)	
[GAP×*IK*-EU](t-1)			1.785
			(0.97)
[GAP×*IK*-USA](t-1)			-0.362
			(-0.44)

[GAP×*IK*-Japan](t-1)			2.648*
			(1.82)
[GAP×*IK*-ROW](t-1)			1.089
			(0.75)
Observations	88	135	134
Adjusted R^2	0.2572	0.1980	0.0141
F-statistic	4.767	6.111	2.628
Hansen Test	12.15	11.95	19.10
p-value	0.205	0.216	0.0244
LM Test	21.70	14.33	12.79
p-value	0.0167	0.158	0.236

t statistics in parentheses with * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Each column refers to a firm characteristic decomposed for the origin of MNCs. All three firm characteristics are expressed as ratios between intensity of MNCs and Domestic firms. GMM estimations instrument endogenous variables *GAP, R, X, IK, GAP×R, GAP×X, GAP×IK* from different origins with their values in periods t-2 and t-3. Hansen statistic refers to over-identification of restrictions in GMM. The joint null hypothesis is that the instruments used are valid, uncorrelated with the error term. Similarly LR statistic refers to under-identification of instruments; a rejection of the null indicates that excluded instruments irrelevant so equation is well identified. P-values are displayed next to the statistics.

5. Conclusion and policy implications

This paper investigated the relative impact of MNE subsidiaries and DOMs activities on regional productivity growth in the UK within a framework of convergence for the period 2004-2011. The analysis made use of firm level data on R&D, intangible assets and exports. Descriptive evidence showed that MNE subsidiaries have higher levels of intensity in R&D, intangibles and exports as compared to DOMs. The econometric results tend to confirm the strong impact of the *multinationality effect* in previous studies where MNE subsidiaries outperform DOMs and thus their contribution to regional growth is far more significant. Nevertheless, there are modifications in the pattern of the results when the *origin of foreignness* of MNEs is taken into account. These results show that the country of origin of the MNE is significant to both regional growth and convergence. Therefore, in the regional context of a developed country, DOMs are likely to be more important components in understanding the puzzle of regional growth than at least some MNE subsidiaries. There are two possible explanations for that: firstly, laggard regions can more easily absorb the organisational expertise of DOMs, which is on average below the standards of the managerial and organisational know-how of MNE subsidiaries. Secondly, the asymmetric effects from the country of origin specifications suggest that MNEs may have different strategies and degrees of embeddedness which may not be equally compatible to local regions' needs.

This poses a major challenge for the design and the implementation of regional inward investment policies as they should be more targeted and more fine-tuned and selective. Policy makers should put forward plans with a key objective the strategically appropriate participation and integration of regions in the production networks of MNEs in order for regions to leverage more effectively gains from global integration. Existing regional policies should depart from viewing regions as border-*bounded territories* to *more global–networked geographical entities* and aim to identify ways in which they can strategically engage with these. This requires focus on and analysis of *specific* MNEs strategies and their degree of embeddedness so as to devise and implement tailor-made regional policies that optimise the joint advantages of MNE subsidiaries and DOMs.

References

Almeida, P., & Phene, A. (2004). Subsidiaries and knowledge creation: The influence of the MNC and host country on innovation. *Strategic Management Journal*, 25(8-9), 847-864.

Altomonte, C., & Pennings, E. (2009). Domestic plant productivity and incremental spillovers from foreign direct investment. *Journal of International Business Studies*, 40(7), 1131-1148.

Anand, J., & Delios, A. (1997). Location specificity and the transferability of downstream assets to foreign subsidiaries. *Journal of International Business Studies*, 579-603.

Andersson, U., Forsgren, M., & Holm, U. (2002). The strategic impact of external networks: subsidiary performance and competence development in the multinational corporation. *Strategic Management Journal*, 23(11), 979-996.

Añón Higón, D., and Manjón Antolín, M. (2012). Multinationality, foreignness and institutional distance in the relation between R&D and productivity. *Research Policy*, 41(3), 592-601.

Bae, S. C., & Noh, S. (2001). Multinational corporations versus domestic corporations: a comparative study of R&D investment activities. *Journal of Multinational Financial Management*, *11*(1), 89-104.

Badinger, H., and Tondl, G. (2005). The factors behind European regional growth: Trade, human capital and innovation. *Jahrbuchfür Regionalwissenschaft*, 25(1), 67-89.

Barrell, R., and Pain, N. (1999). Domestic institutions, agglomerations and foreign direct investment in Europe. *European Economic Review*, 43(4), 925-934.

Barrios, S., Görg, H., & Strobl, E. (2003). Explaining Firms' Export Behaviour: R&D, Spillovers and the Destination Market. *Oxford Bulletin of Economics and Statistics*, *65*(4), 475-496.

Benito, G., Grogaard, B. and Narula, R. (2003), Environmental influences on MNC subsidiary roles: economic integration and the Nordic countries, *Journal of International Business Studies*, 34, 443-456.

Blomström, M and Kokko, A (1996), Multinational corporations and spillovers, Stockholm School of Economics. *Working Paper Series in Economics and Finance* no. 99.

Blomström, M., & Sjöholm, F. (1999). Technology transfer and spillovers: does local participation with multinationals matter? *European Economic Review*, 43(4), 915-923.

Bode, E., Nunnenkamp, P., & Waldkirch, A. (2012). Spatial effects of foreign direct investment in US states. *Canadian Journal of Economics/Revue Canadienne D'économique,* 45(1), 16-40.

Buckley, P. J., Clegg, J., & Wang, C. (2002). The impact of inward FDI on the performance of Chinese manufacturing firms. *Journal of International Business Studies*, 637-655.

Buckley, P. J., Clegg, J., & Wang, C. (2007). Is the relationship between inward FDI and spillover effects linear? An empirical examination of the case of China. *Journal of International Business Studies*, 38(3), 447-459.

Cantwell, J. and S. Iammarino, S. (2000). 'Multinational Corporations and the Location of Technological Innovation in the UK Regions', *Regional Studies*, 34 (4), 317-332.

Cantwell, J., & Mudambi, R. (2005). MNE competence-creating subsidiary mandates. *Strategic Management Journal*, *26*(12), 1109-1128.

Castellani, D. and Zanfei, A. (2006). Multinational Firms, Innovation and Productivity. Edward Elgar Publishing, pp. 100-137.

Caves D., L. Christensen, and E. Diewert. 1982a. The Economic Theory of Index Numbers and the Measurement of Input, Output and Productivity, *Econometrica*, 50(6), 1393–1414.

——. 1982b. Multilateral Comparisons of Output, Input and Productivity Using Superlative Index Numbers, *Economic Journal*, 92, 73–86.

Caves, R. E. (1974). Multinational firms, competition, and productivity in host-country markets. *Economica*, 176-193.

Chung, W., Mitchell, W., & Yeung, B. (2003). Foreign direct investment and host country productivity: the American automotive component industry in the 1980s. *Journal of International Business Studies*, 34(2), 199-218.

Coe, N. M., Hess, M., Yeung, H. W., Dicken, P., & Henderson, J. (2004). 'Globalizing' regional development. *Transactions of the Institute of British Geographers*, 29, 468-484.

Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: a new perspective on learning and innovation. *Administrative Science Quarterly*, 128-152.

Combes, P. P., Duranton, G., & Gobillon, L. (2008). Spatial wage disparities: Sorting matters!. *Journal of Urban Economics*, 63(2), 723-742.

Criscuolo, C., & Martin, R. (2009). Multinationals and US productivity leadership: evidence from Great Britain. *The Review of Economics and Statistics*, 91(2), 263-281.

Cummings, J. L., & Teng, B. S. (2003). Transferring R&D knowledge: the key factors affecting knowledge transfer success. *Journal of Engineering and Technology Management*, *20*(1), 39-68.

Denekamp, J. G. (1995). Intangible assets, internalization and foreign direct investment in manufacturing. *Journal of International Business Studies*, 493-504.

Dettori, B., Marrocu, E., & Paci, R. (2012). Total factor productivity, intangible assets and spatial dependence in the European regions. *Regional Studies*, 46(10), 1401-1416.

Devereux, M. P., Griffith, R., & Simpson, H. (2007). Firm location decisions, regional grants and agglomeration externalities. *Journal of Public Economics*, 91(3), 413-435.

Dimitratos, P., Liouka, I., & Young, S. (2009). Regional location of multinational corporation subsidiaries and economic development contribution: Evidence from the UK. *Journal of World Business*, 44(2), 180-191.

Driffield, N., & Hughes, D. (2003). Foreign and domestic investment: regional development or crowding out? *Regional Studies*, 37(3), 277-288.

Driffield, N., Love, J., Lancheros, S., & Temouri, Y. (2013). How attractive is the UK for future manufacturing foreign direct investment? Future of Manufacturing Project: Evidence Paper 7, Government Office for Science, UK.

Dunning, J. H., & Lundan, S. M. (2008). Multinational enterprises and the global economy. Edward Elgar Publishing.

Dunning, J. H. (1958). American investment in British manufacturing industry. London: George Allen and Unwin.

Dunning, J. H. (1993). Multinational Enterprises and the Global Economy. Addison-Wesley: Wokingham.

Feinberg, S. E., & Gupta, A. K. (2004). Knowledge spillovers and the assignment of R&D responsibilities to foreign subsidiaries. *Strategic Management Journal*, 25(8-9), 823-845.

Frenz, M., & Ietto-Gillies, G. (2007). Does multinationality affect the propensity to innovate? An analysis of the third UK Community Innovation Survey.*International Review of Applied Economics*, *21*(1), 99-117.

Gaur, A. S., & Lu, J. W. (2007). Ownership strategies and survival of foreign subsidiaries: Impacts of institutional distance and experience. *Journal of Management*, 33(1), 84-110.

Gelübcke, J. P. W. (2013). The performance of foreign affiliates in German manufacturing: evidence from a new database. *Review of World Economics*, *149*(1), 151-182.

Girma, S. (2005). Absorptive capacity and productivity spillovers from fdi: A threshold regression analysis. *Oxford Bulletin of Economics and Statistics,* 67(3), 281-306.

Girma, S., & Wakelin, K. (2000). Are there Regional Spillovers from FDI in the UK? Research Paper, 2000/16, Centre for Research on Globalisation and Labour Markets.

Görg, H., & Strobl, E. (2001). Multinational companies and productivity spillovers: A meta-analysis. *The Economic Journal*, 111(475), 723-739.

Greenaway, D., Sousa, N., & Wakelin, K. (2004). Do domestic firms learn to export from multinationals? *European Journal of Political Economy*, 20(4), 1027-1043.

Griffith, R. (1999). Using the ARD establishment level data to look at foreign ownership and productivity in the United Kingdom. *The Economic Journal*, 109(456), 416-442.

Griffith, R., Redding, S., & Van Reenen, J. (2003). R&D and absorptive capacity: Theory and empirical evidence. *The Scandinavian Journal of Economics*, 105(1), 99-118.

Griffith, R., Redding, S., & Van Reenen, J. (2004). Mapping the two faces of R&D: Productivity growth in a panel of OECD industries. *Review of Economics and Statistics*, 86(4), 883-895.

Griffith, R., Redding, S., and Simpson, H., (2009), Technological Catch-Up and Geographic Proximity. *Journal of Regional Science*, 49(4), 689-720.

Håkanson, L., Nobel, R., (2001). Organizational Characteristics and Reverse Technology Transfer. *Management International Review*, 41, 395-420.

Hall, R. E. (1988). The relation between price and marginal cost in U.S. industry. *Journal of Political Economy*, 96, 921–947.

Hall, R. E. (1991). *Invariance properties of Solow's productivity residual* (No. w3034). National Bureau of Economic Research.

Harris, R., & Li, Q. C. (2009). Exporting, R&D, and absorptive capacity in UK establishments. *Oxford Economic Papers*, 61(1), 74-103.

Harris, R. (2011). Models of regional growth: past, present and future. *Journal of Economic Surveys*, 25(5), 913-951.

Haskel, J. E., Pereira, S. C., & Slaughter, M. J. (2007). Does inward foreign direct investment boost the productivity of domestic firms? *The Review of Economics and Statistics*, 89(3), 482-496.

Hymer, S. (1976). The international operations of national firms: A study of direct foreign investment (Vol. 14, pp. 139-155). Cambridge, MA: MIT press.

Johanson, J., & Vahlne, J. E. (2009). The Uppsala internationalization process model revisited: From liability of foreignness to liability of outsidership. *Journal of International Business Studies,* 40(9), 1411-1431.

Keller, W., & Yeaple, S. R. (2009). Multinational enterprises, international trade, and productivity growth: firm-level evidence from the United States. *The Review of Economics and Statistics*, *91*(4), 821-831.

Kramer, J. P., Marinelli, E., Iammarino, S., & Diez, J. R. (2011). Intangible assets as drivers of innovation: Empirical evidence on multinational enterprises in German and UK regional systems of innovation, *Technovation*, 31(9), 447-458.

Lee, K. C., & Kwok, C. C. (1988). Multinational Corporations vs. Domestic Corporations: International Environmental Factors and Determinants of Capital Structure, *Journal of International Business Studies*, 19(2), 195-217.

Liu, X., Siler, P., Wang, C., & Wei, Y. (2000). Productivity spillovers from foreign direct investment: evidence from UK industry level panel data. *Journal of International Business Studies*, 407-425.

Lucas Jr, R. E., & Rossi-Hansberg, E. (2002). On the internal structure of cities. *Econometrica*, 1445-1476.

Mariotti, S., Mutinelli, M., Nicolini, M., & Piscitello, L. (2014). Productivity Spillovers from Foreign Multinational Enterprises to Domestic Manufacturing Firms: To What Extent Does Spatial Proximity Matter? *Regional Studies*, 1-15.

Markusen, James R. (1995): The boundaries of multinational enterprises and the theory of international trade. *Journal of Economic Perspectives*, 9, 169-189.

Markusen, J. R., & Venables, A. J. (1998). Multinational firms and the new trade theory. *Journal of International Economics*, 46(2), 183-203.

Mata, J., & Freitas, E. (2012). Foreignness and exit over the life cycle of firms. *Journal of International Business Studies*, 43(7), 615-630.

Meyer, K. E., Mudambi, R., & Narula, R. (2011). Multinational enterprises and local contexts: the opportunities and challenges of multiple embeddedness. *Journal of Management Studies*, 48(2), 235-252.

Narula, R., & Driffield, N. (2012). Does FDI cause development? The ambiguity of the evidence and why it matters. *European Journal of Development Research*, 24(1), 1.

Papanastassiou, M., & Pearce, R. (1997). Technology sourcing and the strategic roles of manufacturing subsidiaries in the UK: local competences and global competitiveness. MIR: *Management International Review*, 5-25.

Perkmann, M. (2006). Extra regional linkages and the territorial embeddedness of multinational branch plants: evidence from the South Tyrol region in Northeast Italy. *Economic Geography*, *82*(4), 421-441.

Phelps, N. A., Mackinnon, D., Stone, I. and Braidford, P. (2003). Embedding the multinationals? Institutions and the development of overseas manufacturing affiliates in Wales and North East England, *Regional Studies*, 37(1), 27-40.

Rice, P., and Venables, A. (2003). Equilibrium regional disparities: theory and British evidence. *Regional Studies*, 37(6-7), 675-686.

Roeger, W. (1995). Can imperfect competition explain the difference between primal and dual productivity measures? Estimates for U.S. manufacturing. *Journal of Political Economy*, 103(2), 316–331.

Temouri, Y., Driffield, N. L., & Higón, D. A. (2008). Analysis of productivity differences among foreign and domestic firms: evidence from Germany. *Review of World Economics*, 144(1), 32-54.

World Investment Report (2012). Towards a New Generation of Investment Policies, UNCTAD: Geneva.

Zaheer, S. (1995). Overcoming the liability of foreignness. *Academy of Management Journal*, 38(2), 341-363.

APPENDICES

A1. The methodological novelty of the HR approach is to combine production and cost based Solow residual (SR) eliminating unobservable productivity shocks and thus obtaining an unbiased measure of market power. SR is defined as the difference in growth rates of output and inputs as follows:

$$SR \equiv \frac{\Delta Y}{Y} - \alpha \frac{\Delta L}{L} - (1-\alpha)\frac{\Delta K}{K} = \beta(\frac{\Delta Y}{Y} - \frac{\Delta K}{K}) + (1-\beta)\frac{\Delta \theta}{\theta} \tag{A1}$$

The first side of (1.14) is equivalent to the growth rate of SR as derived from growth accounting with α standing for the share of total wage bill in value added. In the existence of market power, parameter β captures a measure of Lerner index, which is the ratio $\frac{p-MC}{p}$, where *p* is price and *MC* is marginal cost. If thee estimated coefficient of β is greater than 1 then there is imperfect competition. In (1.14) there is the inherent endogeneity between rates of productivity growth and the error term. Roeger (1995) has used the cost based version of SR as follows:

$$CSR \equiv \alpha \frac{\Delta w}{w} + (1-\alpha)\frac{\Delta r}{r} - \frac{\Delta p}{p} = -\beta(\frac{\Delta p}{p} - \frac{\Delta r}{r}) + (1-\beta)\frac{\Delta \theta}{\theta} \tag{A2}$$

Where *w* is wage and r is the cost price for capital stock use. Subtracting equation (1.15) from (1.14) and re-arranging we obtain:

(A3)

In a compact way, we obtain estimates for μ from a cost based SR:

$$\Delta y = \mu \Delta x \tag{A4}$$

All values in (1.16) are fully observable, Δy is approximated by the difference in the log value of value added minus the difference in the log value of capital stock. Δx is approximated by the difference in the log value of labour compensation. The parameter α is observable and it is measured as the share labour compensation to value added.

B.

Table 1: Mean Values of TFP Growth and Distance from the Frontier for UK Regions (NUTS Level 2), 2004-2011

NUTS 2	Region	TFPG	Distance	TFP
UKC1	Tees Valley and Durham	-0.17%	0.60	2.16
UKC2	Northumberland and Tyne and Wear	-6.09%	0.55	2.04
UKD1	Cumbria	4.81%	0.45	1.89
UKD3	Greater Manchester	-15.85%	0.68	2.15
UKD4	Lancashire	6.98%	0.42	1.64
UKD6	Cheshire	6.01%	0.54	1.84
UKD7	Merseyside	-8.01%	0.56	1.98
UKE1	East Yorkshire and Northern Lincolnshire	2.79%	0.39	1.64
UKE2	North Yorkshire	-3.48%	0.56	1.86
UKE3	South Yorkshire	-7.46%	0.57	2.11
UKE4	West Yorkshire	-5.80%	0.50	1.93
UKF1	Derbyshire and Nottinghamshire	0.61%	0.53	2.08
UKF2	Leicestershire, Rutland and Northamptonshire	1.84%	0.45	1.87
UKF3	Lincolnshire	-0.16%	0.52	1.98
UKG1	Hereford, Worcestershire and Warwickshire	-0.08%	0.94	2.37
UKG2	Shrophire and Staffordshire	4.42%	0.38	1.58
UKG3	West Midlands	-9.35%	0.54	2.10
UKH1	East Anglia	5.01%	0.43	1.61
UKH2	Bedfordshire and Hertfordshire	-1.66%	0.77	2.30
UKH3	Essex	3.49%	0.53	1.84
UKI1	Inner London	-3.79%	0.76	2.37
UKI2	Outer London	-3.98%	0.67	1.95
UKJ1	Berkshire, Buckinghamshire and Oxfordshire	2.44%	0.68	2.24
UKJ2	Surrey, East and West Sussex	3.11%	0.57	1.95
UKJ3	Hampshire and Isle of Wight	2.51%	0.49	1.94
UKJ4	Kent	-1.56%	0.74	2.16
UKK1	Gloucestershire, Wiltshire and Bristol/Bath area	4.78%	0.44	1.80
UKK2	Dorset and Somerset	-0.27%	0.56	1.96
UKK3	Cornwall and Isles of Scilly	1.92%	0.48	1.65
UKK4	Devon	-1.21%	0.64	2.04
UKL1	West Wales and The Valleys	2.00%	0.50	1.83
UKL2	East Wales	0.65%	0.56	2.03
UKM2	Eastern Scotland	0.16%	0.75	2.23
UKM3	South Western Scotland	3.18%	0.53	1.96
UKM5	North Eastern Scotland	-2.90%	0.76	2.26
UKM6	Highlands and Islands	7.22%	0.47	1.82
Mean		0.003	0.57	1.98

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Table 2: R&D, Exports and Intangibles of MNCs Relative to Domestic Firms for the UK, 2004-2011

Region	R&D	Exports	IK
UKC1	0.86	1.03	19.24
UKC2	0.69	1.13	7.12
UKD1	3.98	0.25	5.53
UKD3	0.77	9.68	22.15
UKD4	0.67	1.54	3.70
UKD6	7.97	12.80	10.15
UKD7	2.86	0.62	39.00
UKE1	0.60	2.70	14.88
UKE2	5.04	8.80	33.97
UKE3	1.39	15.25	59.68
UKE4	3.34	3.56	2.54
UKF1	70.45	0.87	1.27
UKF2	2.57	6.20	256.24
UKF3	2.43	2.75	7.16
UKG1	0.11	1.49	18.90
UKG2	0.24	2.10	1.40
UKG3	0.42	13.23	35.35
UKH1	4.95	3.04	5.73
UKH2	5.18	2.56	3.46
UKH3	13.37	0.93	18.24
UKI1	10.69	0.89	9.01
UKI2	1.27	2.31	26.41
UKJ1	2.04	2.51	7.76
UKJ2	2.23	2.12	14.28
UKJ3	6.50	2.32	4.65
UKJ4	0.94	4.93	5.11
UKK1	0.81	2.54	11.38
UKK2	1.00	1.69	4.19
UKK3	1.79	0.02	5.71
UKK4	1.98	3.49	322.32
UKL1	2.18	1.97	0.67
UKL2	0.37	2.00	17.03
UKM2	5.20	5.33	0.73
UKM3	0.66	1.70	2.60
UKM5	6.04	0.46	9.73
Mean	4.9	3.57	28.78

Appendix D: Definition of Variables

Name	Definition
Regional TFP	
Output	Gross Value Added (GVA) expressed in 1995 GBP constant prices, using production price indices (PPI), Office of National Statistics (ONS), Regional Accounts
Labour	Number of employees, ONS
Labour share	Labour compensation ratio to GVA, labour compensation expressed in 1995 GBP constant prices suing ULC indices takes from OECD-STAN(2010)
Investment	Gross Fixed Capital Formation expressed in 1995 GBP constant prices using Capital price index, ONS
Firm Level Data-FAME	
R&D (R)	Expenditures in R&D in current GBP
Exports (X)	Turnover from overseas sales in current GBP
Intangibles (IK)	Expenditures in Intangible Assets in current GBP