Coagglomeration and Growth*

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Abstract

Using plant-level data for the Irish manufacturing sector over the period 1983-98, we study the coagglomeration of domestic plants and foreign multinationals in Ireland. To this end we make use of the index developed by Ellison and Glaeser (1997) and find coagglomeration to be important for a number of sectors. We further test for the impact of coagglomeration on domestic firms' employment growth using panel level data. Foreign presence as well as foreign employment density are found to be important determinants of employment growth over the period, especially for those sectors with a high degree of coagglomeration.

JEL classification: F23, R3, Q40

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1. Introduction

The idea that *growth is localized* is an old one and goes back to various authors such as Perroux (1955), Myrdal (1957) and Hirschman (1958). The main argument of these authors is that proximity of heterogeneous activities favors cross-fertilization. Solutions to problems in a particular industry *and* geographical area can be mimicked in other areas for the same or related industries. However, as knowledge only spreads slowly through space, agglomeration of economic activity tends to foster the emergence of innovation clusters. More recently, the links between agglomeration and regional economic development have attracted growing attention. As Lucas (1988) already pointed out in his seminal paper, externalities that are at the source of endogenous growth are mostly local in nature since they concern interactions between agents. The same holds for Romer-type models where location of hi-tech firms and R&D activities may arguably matter for economic growth and development through knowledge-related externalities. Some recent theoretical works have considered more explicitly possible linkages between agglomeration and regional growth using a dynamic approach including Walz (1996), Baldwin (1999), Martin and Ottaviano (1999, 2001), Baldwin *et al.* (2001), Fujita and Thisse (2002, chap.11), as well as Black and Henderson (1999) in an urban economics framework. Besides these theoretical contributions, a vast empirical literature relating to these issues has developed, mainly oriented towards urban economics. Empirical evidence has been provided in Tabuchi (1986), Glaeser *et al.* (1992), Henderson *et al.* (1995) de Lucio *et al*. (2002) and Dekle (2002). Special emphasis is generally put on identifying the nature of externalities arising in urban growth, the main question being whether such externalities are industry-specific (*à la* Marshall-Arrow-Romer) or based on cities' diversity of industries (as argued by Jacobs, 1969). Transferring the same questioning in an innovation setting, Audretsch and Feldman (1996) and Feldman and Audretsch (1999) ask whether specialization or diversity of R&D activities favor innovation, and it turns out that innovation is more prone to the local presence of diversified R&D activities.

The present paper takes a somewhat different angle. We ask the question whether agglomeration may affect regional economic growth by looking at a particular case where agglomeration and growth may go hand in hand. More specifically, *we study the coagglomeration between domestic and foreign firms in Irish manufacturing industry* and *the*

way this may have fostered indigenous plants' growth. An often cited stylised fact is that the recent spectacular Irish economic boom has largely been influenced by huge foreign direct investment (FDI) inflows.[1] The empirical evidence provided here shows that FDI has been especially vigorous in some traditionally disadvantaged regions such as Galway, Limerick, and Donegal, promoting employment outside the Dublin area where manufacturing employment used to be concentrated. We also show that the rise in foreign employment has generally been accompanied by domestic employment growth giving support for the existence of positive spillovers between foreign firms and their domestic counterparts.

Following the literature on FDI, multinationals may affect the host economy through a number of channels (see Markusen and Venables (1999) and Blomström and Kokko (1998)). More remarkably, the forces generally invoked in the economic geography related literature for economic agglomeration to take place (i.e. labor market pooling, backward-forward linkages and technological externalities) are put forward when assessing the possible impact of multinational firms on domestic plants. Multinationals are often viewed as modern firms using innovative production processes and employing skilled workers and also benefiting from R&D services from their headquarters (see Markusen, 1995). If spillovers arise between firms geographically concentrated then domestic firms may in turn benefit from R&D spillovers related to multinational activities. Domestic firms may also take advantage of backward-forward linkages with multinationals. For example, Markusen and Venables (1999) show that foreign firms may exacerbate indigenous industrial development by using local intermediate products. Domestic firms, by getting acquainted with new production techniques and benefiting from larger diversity of intermediate products may ultimately compete with foreign firms. FDI-related backward-forward linkages are thus closely related with technological externalities and demonstration effects since foreign firms generally use technology-intensive intermediates, pushing domestic firms to adopt new production standards (see Blomström, 1986).

The existing empirical evidence on possible spillovers emanating from foreign presence points toward a potentially important impact of FDI on local industrial development, although most studies do not take the intra-national dimension of spillovers into account (see Görg and Strobl, 2001). The focus of the present paper is essentially concerned with the regional dimension

[1] See Barry and Bradley (1998).

of FDI-related externalities. *The first question we consider is whether there is an advantage for domestic plants to locate close to foreign multinational in order to avail of the potential externalities related to foreign presence*. To this end we use exhaustive information on domestic and foreign plants' location in 27 counties of Ireland for the period 1972-1998. Our basic conjecture is that multinationals mainly aim at using Ireland as a base for exports and do not directly compete with domestic firms on their product market. Positive spillovers emanating from co-location between multinationals and domestic firms are then expected to be much more important for the latter. We use the *coagglomeration index* developed by Ellison and Glaeser (1997) in order to examine this hypothesis. Our results point toward substantial coagglomeration between multinationals and domestic plants for nearly half of the industrial sectors examined, providing some evidence of significant FDI-related local spillovers. Coagglomeration is also found to grow significantly in a number of sectors over the period 1972-1998 when considering Nace 2 digit rather than Nace 3 digit industries providing evidence for spillovers within broadly defined industries where externalities such as backward-forward linkages are more likely to be captured.

The second question examined concerns the possible impact of foreign presence on regional growth. To this end we make use of a panel of Irish-owned plants over the period 1983-1998 to see whether foreign presence has had a significant impact on domestic plants' employment growth. Our basic assumption is that for a given industry, if a domestic plant benefits from being located in a county with high foreign presence then it will grow at a faster pace than other domestic plants located elsewhere in Ireland. The results indicate a positive and significant impact of foreign presence on domestic plants' employment growth especially for those plants belonging to industries where coagglomeration was found to be significant over the period considered. The evidence presented here thus suggests that *domestic and foreign plants' location choice are strongly correlated and that, in turn, foreign presence has largely contributed to domestic employment growth at the regional level. Location thus matters for growth.*

The rest of the paper is organized as follows. In the next section we present the data and method used to construct the measure of coagglomeration index as well as its evolution over the 1972-1998 period. In section 3 we conduct an econometric test of the impact of foreign presence on domestic employment growth for the 1983-98 period. Section 4 concludes.

2. Coagglomeration between domestic and multinational firms in Ireland

The Irish economy has experienced strong structural changes over the last 30 years, not least the effects of EU-integration in 1974 on trade flows and the huge rise in foreign direct investment (FDI) especially since the mid-1980's providing Ireland with strong competitive positions in hi-tech industries such as pharmaceuticals and semi-conductor sectors, whereas in earlier periods Irish industry was strongly oriented towards the production of more traditional goods (see Barry and Bradley, 1997). Important changes have also occurred from a regional perspective. In particular, some regions with traditionally low manufacturing employment in Ireland have seen their share in total Irish employment rising from 1972 to 1999.

Using the data from the *Forfás Employment Survey*[2], an exhaustive survey of all known active manufacturing plants in Ireland since 1972, Graph 1 shows *that while county Dublin harbored nearly 40% of total manufacturing employment in 1972, this share has since then steadily declined to stand at less than 25 % in 1999*.[3] Table 1 and the maps in appendix show in addition that counties like Kildare, Galway, Limerick have seen their share in total manufacturing employment rise significantly and become larger than their relative share in total population. In particular the last two counties, traditionally given "disadvantaged" status, have been successful in attracting foreign investors. In a recent paper, Barrios et al. (2002) show that investment promotion in those counties has been effective in attracting foreign investors. The preceding authors also show that agglomeration economies have been an important determinant of FDI inflows into Irish counties. Moreover, counties with good transport infrastructure, skilled workers and low land cost have especially benefited from foreign investment. Table 2 provides additional evidence concerning the geographical distribution of foreign plants start-up in Ireland over the period 1972-1999. While a large proportion of foreign investment have come from the United States, we also observe that a growing share of FDI has been oriented toward disadvantaged areas over the period.

The question we raise in the next section is whether we observe common patterns in location of both foreign and multinational plants. If domestic and foreign business units tend to locate close together then one may reasonably hypothesize that there are advantages in doing so.

[2] Details of this data source are provided in the Data Appendix.
[3] Note that from now on we will use the terms *county* and *region* indistinctly.

2.1 Measuring coagglomeration

There is now an important literature analyzing foreign multinationals' location choice, in particular in the United States (see for example Coughlin *et al.* 1991, Smith and Florida 1994 and Head *et al.* (1999)).[4] Our concern here is rather different since we consider how domestic plants and foreign affiliates' location choice influence each other through the existence of positive spillovers. As a first step we are interested in analyzing whether the location of domestic plants coincides with the location of foreign plants, *without, as of yet, assessing causality*. Hence we need a tool to identify the patterns of coagglomeration between foreign and domestic plants. To this end, a number of indices are at hand. The most commonly used has been the Gini index, which measures the distribution of industry by employment and/or output relative to a perfectly uniform distribution across space. The advantage of the Gini index lies in its computational ease which has led economists to use this index widely. Graph 2 reports the evolution of this index over the 1972-1999 period for the Irish total manufacturing employment as well as for foreign employment solely.[5] The evolution reinforces previous evidence showing that, overall, *manufacturing employment tend to be more dispersed across time in Ireland while foreign presence measured by the share of total employment that is made by foreign firms have increased significantly over the same period going from 33% in 1972 to 47% in 1999.*

A major drawback related to the use of the Gini index lies in its sensitiveness to economies of scale. As a consequence, the spatial concentration of workers may be due at least partly to the existence of internal economies of scale. Ellison and Glaeser (1997) thus have proposed an index of spatial concentration which presents the desirable feature of neutralizing the possible influence of plants' and regions' size. Its expression for a particular industry *i* is given by:

$$\gamma_i \equiv \left[G_i - \left(1 - \sum_c x_c^2\right) H_i\right] \Big/ \left[\left(1 - \sum_c x_c^2\right)\left(1 - H_i\right)\right] \qquad (1)$$

where G_i is an approximation of the Gini index defined as the sum of squared deviations of s_{ic} (the share of industry *i*'s employment in area *c*) to x_c (the share of aggregate manufacturing

[4] Those papers follow more general empirical studies on plants' location choice, in particular by Carlton (1983) Bartik (1985) and Schmenner *et al.* (1987)

[5] The data appendix provides more details about the classification as foreign or domestic plant.

employment in area *c*), i.e. $G_i = \sum_c (s_{ic} - x_c)^2$. The term $H_i = \sum_j z_{ij}^2$ represents the classical Hirschman-Herfindahl index defined as the sum of squared plant employment shares by industry *i*, with *j=1…N* the plant-indices. The Ellison Glaeser (from now on EG) index is then comparable across time and across sectors regardless of plants' size distribution. The first property is arguably helpful when dealing with the evolution of the concentration of industries over a long time span as the one considered here. The EG has another important property: it is based on a location model, i.e., where firms choose location following a Bernoulli process according to the presence of natural advantage and/or spillovers. The index thus asks the question whether concentration is greater than would be expected to arise randomly.[6]

A related question is to know whether the groups we make reference to, both sectors and geographic areas, represent homogenous entities. The same holds when measuring the concentration of large and small plants, or the concentration of *n*-digit rather than *(n+1)*-digit industries.[7] A corollary to this as proposed by Ellison and Glaeser (1997) then consists in computing the concentration of the finer disaggregation, and in a second step to see whether there is coagglomeration among these disaggregated units of observation. Some industries may coagglomerate because of common natural advantages on choosing certain location or because of backward-forward linkages existing between them. The resulting index will then be a function of individual sectors' indices and of the relative share of sub-industries in broadly defined industries' total employment. Instead of using the coagglomeration index defined over different sectoral breakdown here we consider coagglomeration between *domestic* and *foreign* firms. That is, instead of looking at how different sub-industries belonging to a given broad industry coagglomerate, *we consider the way domestic and foreign firms coagglomerate for a given industry*. The corresponding coagglomeration index of Ellison and Glaeser can be written as follows:

[6] One should note however that a major limitation of the EG index is that one cannot distinguish between spillovers and natural advantages to explain the reasons why plants agglomerate. This is simply due to the fact that there is an observational equivalence between natural advantage and spillovers. However, the case of the Irish economy considered here simplify things since natural-advantage based industries outside of agriculture (for example, industries like mining) are of little importance.

[7] Although in a different context, Moomaw (1998) argues that estimated agglomeration economies are not likely to be influence by industrial aggregation.

$$\gamma_i^{Co} \equiv \frac{\left[G_i / \left(1 - \sum_c x_c^2\right) - H_i - \sum_k \hat{\gamma}_{i,k} w_{i,k}^2 \left(1 - H_{i,k}\right)\right]}{1 - \sum_{k=1}^{r} w_{i,k}^2} \qquad (2)$$

where $k=d,f$ indicates whether the index refers to domestic or foreign plants respectively and w_k represents the employment share of domestic and foreign employment in total employment of industry i. A value of $\gamma_i^{Co} = 0$ indicates that foreign and domestic industries exhibit no coagglomeration at all (i.e. any spillovers/natural advantages found within the domestic/foreign groups are completely *group-specific*), whereas positive and large values of γ_i^{Co} indicate that the natural advantages and spillovers that exist are *industry-specific* (spillovers benefit foreign as well as domestic firms in an industry and/or natural advantages are perfectly correlated). In order to consider the kind of coagglomeration depicted by Ellison and Glaeser we will also consider different industry-breakdowns like Nace 2 and 3 digits.

2.2 Evidence for the Irish manufacturing sector, 1972-1998

Table 3 presents results for 49 Nace 3 digit industries that were present in Ireland in 1972, 1985 and 1999.[8] Overall, there seems to be positive coagglomeration though it is has been slightly decreasing on average over the years. We find that for all three years considered in table 3, around 30 sectors out of 49 have positive coagglomeration coefficients and 18 of those have coefficients above the industry-wide average. In addition, we find that the ranking of sectors seems quite stable over the years. Spearman rank correlation coefficients were computed between 1972-1985, 1985-1999 and 1972-1999 and we obtain positive and significant correlations except for the whole period providing support for some important changes over the last 30 years or so. Some sectors have seen their coagglomeration coefficient rise dramatically over this period like Nace 153 (Processing and preserving of fruit and vegetables), Nace 171 (Preparation and spinning of textile fibres) and Nace 177 (Knitted and crocheted articles), while others experienced a fall going from positive and large coefficients to become negative as, for example, Nace 175 (Other textiles), Nace 261 (Glass and glass products) and Nace 362 (Jewellery and

related articles). Note however that a high volatility of the coagglomeration index may also be due to the small size of sectors in total employment and/or the small number of plants in each of these sectors. The same exercise was then performed across Nace 2 digit sectors providing us with a breakdown of 18 sectors and with much more stable evolutions in the indices. We do not report them here for brevity although results are similar to ones for the Nace 3 digit industries as can be seen through the Spearman rank correlations also reported in the lower part of table 3.

In order to see whether we observe some trends in the changes of the coagglomeration indices by sector we have constructed transition matrices dividing up sectors according to the sign of their index. Table 4 shows those matrices for annual and 5-year changes using both 2 and 3-digit Nace classifications. One observes that the probability for a sector to experience no change in the sign of its index rises when considering annual rather than 5-years interval. This comforts the view that there is important inertia in the short run, but that changes can occur over a longer time span. Again, from the Nace 3 digits it is hard to see any trend toward dispersion or coagglomeration since the transition probability of going from positive to negative and the one going from negative to positive are generally comparable. The same does not hold when using the Nace 2 digits classification. We now obtain a larger proportion of sectors that go from negative to positive values of the index no matter which time period is being considered. We interpret this as an indication that coagglomeration mainly occurs within broad-sectors where externalities such as backward-forward linkages, as proposed in the FDI and economic geography related literature, are more likely to take place.

When considering possible impact of coagglomeration on employment growth one may expect three possible outcomes. The first one is that foreign presence has no significant impact on local growth. A second possible outcome is that there is a positive impact of FDI on local growth if positive spillovers of the kind described above arise. However, one can perfectly conceive as a third alternative domestic firms that would be wiped out of the market because of competition effect (as in Markusen and Venables, 1999). Moreover, domestic firms' employment may also decrease because of labor market poaching by multinational firms if, for example, multinationals pay higher wages and then attract workers from domestic firms. Foreign firms may then have a

[8] The total number of manufacturing industries available is in fact equal to 101 though not all have experienced FDI in which case we cannot compute the coagglomeration index. In addition, some industries are not present for the whole period considered here.

positive influence on total employment growth but not necessarily on domestic employment growth. This can be observed in table 5 showing at the county-level total and domestic employment growth over different time periods together with the level and changes of foreign presence measured by foreign share of total employment. We can see that counties like Galway or Limerick have experienced both a huge rise in total and domestic employment and also in foreign presence. This seems to go in favor of the second scenario. On the other hand counties like Clare, Cork, Kildare or Waterford have also experienced a rise in foreign presence but also a steady decline in domestic employment providing support for the third view. It is then difficult to assess the general impact of foreign presence on local growth with the descriptive statistics at hand and one needs to consider possible sector and region-specific effects as well as plant-specific characteristics. This is the purpose of the following section.

3. Coagglomeration and growth: a panel data analysis

3.1 The Model

In this section we test the impact of foreign presence on employment growth for a panel of domestic Irish manufacturing plants. The model tested is derived from a standard production function, similar to the one used by Glaeser *et al.* (1992) with the difference that we account for capital and output in the labor demand equation of domestic plants. We start from a production function of a plant *j* in industry *i* at time *t* as described by equation (3) below:

$$\pi_{j,t} = A_{i,t} f\left(l_{j,t}, k_{j,t}\right) - w_{j,t} l_{j,t} - r_t k_{j,t} \qquad (3)$$

where f is the production function to be specified later, and l and k are labor and capital stock used for production, $w_{j,t}$ and r_t are the cost of labor and capital respectively, while A is a Solow residual that we assume to be Hicks-neutral. We also consider that prices of final goods to be given and normalized to one. This price-taker assumption is not restrictive when taking into account that Ireland is a small open economy. We also consider the wage rate $w_{j,t}$ to be plant-specific while r_t is considered as common to all firms within the country, thus supposing perfect

capital mobility and imperfect labor mobility. [9] Labor demand can be expressed by equating wage and the marginal product of labor as depicted by the equation below:

$$A_{i,t} f_l\left(l_{j,t}, k_{j,t}\right) = w_{j,t} \tag{4}$$

Rewriting (4) in terms of growth rates using natural logarithm and using Δ as the difference operator gives:

$$\Delta \ln\left(A_t\right) = \Delta \ln\left(w_{j,t}\right) - \Delta \ln\left(f_l\left(l_{j,t}, k_{j,t}\right)\right) \tag{5}$$

As argued earlier, local plants may benefit from foreign presence through a number of linkages and especially through backward-forward linkages and technological spillovers. The first kind of pecuniary externality arises if foreign firms use domestic intermediate goods as inputs while technological externalities arise because multinationals generally use modern production techniques and they also embody a large part of R&D services coming from their headquarters or from other plants belonging to the same firm (see Markusen and Venables, 1999). In addition, foreign multinationals generally use modern production techniques and their presence on the domestic market may push local firms to similarly adopt these. Both kinds of externalities are compatible since foreign multinationals generally need high-quality intermediate inputs which may represent an additional incentive for domestic providers to improve their productivity. We then consider that the growth rate of the productivity parameter *A* is determined by the presence of foreign multinational in the county-sector at the base period *t-1*. Denoting *i* the index for the industry, *c* the index for the county, and assuming productivity growth to be a function of foreign presence in county *c* and industry *i* we write:

$$\Delta \ln\left(A_{i,t}^{c}\right) = e^{g\left(FP_{i,t-1}^{c}\right) + \upsilon_j} \tag{6}$$

where *FP* is a measure of foreign presence to be explained later while υ_j represents plant-specific characteristics determining plants' productive efficiency that we assume to be time-invariant. We can now determine the equation for labor demand considering that the production level *y* is determined by a simple CES production function with the following form:

[9] Decentralized wage negociations in Ireland reinforce our assumption on wage formation. Unlike most continental

$$y_{i,j,t} = A_{i,t} f\left(l_{i,j,t}, k_{i,j,t}\right) = A_{i,t}\left[\theta k_{i,j,t}^{-\rho} + (1-\theta) l_{i,j,t}^{-\rho}\right]^{-\frac{1}{\rho}} \quad (7)$$

where θ and ρ are parameters.

Differentiating *f* with respect to *l* equals to:

$$f_l\left(l_{i,j,t}, k_{i,j,t}\right) = (1-\theta)\left(\frac{y_{i,j,t}}{A_{i,t} l_{i,j,t}}\right)^{1+\rho} \quad (8)$$

Using (5), (6) and (8) and introducing the relevant subscripts and superscripts, we can determine the employment growth using first difference of the natural logarithm of employment for a plant *j* located in county *c* and industry *i* at time *t* as follows:

$$\Delta \ln\left(l_{i,j,t}^{c}\right) = a + b \cdot \Delta \ln\left(y_{i,j,t}\right) - c \cdot \Delta \ln\left(w_{i,j,t}\right) + d \cdot g\left(FP_{i,t-1}^{c}\right) \quad (9)$$

where *a, b, c* and *d* are parameters depending among others on the elasticity of substitution σ between labor and capital and on θ. If positive externalities are sector-specific then domestic plants may potentially benefit from foreign presence within the same sector. Put differently, domestic plants may benefit from being co-located near foreign plants in the same county and thus employment growth as expressed by (9) must be positively related to foreign presence. Our basic hypothesis derives naturally from the previous assumption and can be expressed as follows:

For a given sector, if domestic plants benefit from foreign presence then plants located in a county with high foreign presence will grow more than plants located in counties with low foreign presence, ceteris paribus.

The preceding hypothesis can be expressed using (9) and rewriting it in terms of deviation with respect to the rest of Ireland. Using first differences of the natural logarithm to represent employment growth rates, we obtain the equation given below:

$$\Delta \ln\left(\frac{l_{i,j,t}^{c}}{l_{i,t}^{-c}}\right) = a + b\,\Delta \ln\left(\frac{y_{i,j,t}^{c}}{y_{i,t}^{-c}}\right) - c\Delta \ln\left(\frac{w_{i,j,t}^{c}}{w_{i,t}^{-c}}\right) + d\,G\left(\frac{FP_{j,t-1}^{c}}{FP_{i,t-1}^{-c}}\right) \quad (10)$$

EU economies, Ireland has no tradition of sector level bargaining and only 25 per cent of private sector enterprises are formally covered by central wage setting.

Superscript *–c* is used in order to represent the *rest of the country*, that is, $\Delta\ln\left(l^{c}_{i,j,t}/l^{-c}_{i,t}\right)$ represents the employment growth of a plant based in county *c* and industry *i* compared to the rest of plants from the same sector but based in any other county different from *c*.

Since equation (10) is expressed in growth rates one could argue that the dependent variable may also be influenced by industry or county-specific shocks that our model does not capture. For example, firms in hi-tech industries tend to grow faster than other firms in traditional or declining-demand industries. In order to control for this possibility we also included as explanatory variable the employment growth rate of the county-industry relative to the growth rate for the same industry excluding county *c*, i.e. $\Delta\ln\left(l^{c}_{i,t}/l^{-c}_{i,t}\right)$. In addition, industry-specific effects that are not directly related with foreign presence may explain part of the employment growth of Irish manufacturing firms and not taking into account of these may bias our estimates. For example some important structural changes independent of the rise in foreign presence may have occurred in some particular sectors (for example the computing industry). We thus also included a set of sector-specific dummies represented by γ_i. Moreover a set of time dummies τ_t were added in order to control for possible country-wide shocks. The final equation to be estimated is then given by equation (11) below:

$$\Delta\ln\left(\frac{l^{c}_{i,j,t}}{l^{-c}_{i,t}}\right)=a'+f'\Delta\ln\left(\frac{l^{c}_{i,j,t-1}}{l^{-c}_{i,t-1}}\right)+b'\Delta\ln\left(\frac{y^{c}_{i,j,t}}{y^{-c}_{i,t}}\right)-c'\Delta\ln\left(\frac{w^{c}_{i,j,t}}{w^{-c}_{i,t}}\right)+d'G\left(\frac{FP^{c}_{i,t-1}}{FP^{-c}_{i,t-1}}\right)+g'\Delta\ln\left(\frac{l^{c}_{i,t}}{l^{-c}_{i,t}}\right)+\mu_j+\gamma_i+\tau_t+\varepsilon_{j,t} \qquad (11)$$

where $\varepsilon_{j,t}$ is *i.i.d* and μ_j is a plant-specific effect which potential influence will be considered in the next section.[10] Equation (11) corresponds to our main hypothesis stating that the relative employment growth of a plant *j* located in county *c* belonging to industry *i* compared to the average employment growth in the same sector but outside county *c* is positively related to the relative foreign presence in the county in which plant *j* is located. Put differently, the advantage (in terms of employment growth) of being co-located is represented here by the expected positive relationship between the relative employment growth and the relative foreign presence. We then assume that all firms within the same county-industry share the same advantage related to foreign

[10] The first RHS variable is the lagged dependent variable. Section 3.2 expounds its importance.

presence, ceteris paribus. As for employment, all other firm-specific variables are expressed in terms of deviations with respect to average values for the rest of the country within the same industry. The expected sign for *b'* is positive given that an increase in output increases labor demand, *-c'* is expected to be negative while *d'* should be positive if positive externalities arise from co-locating with foreign firms.

The variable of overriding importance in our empirical estimation is foreign presence. In the empirical literature on foreign direct investment, FDI is generally measured by the share of foreign affiliates in total employment by sector (Görg and Strobl, 2001), and this is the measure we have used so far. One should note that given that the *Forfás Employment Survey* is an exhaustive survey, our measure of foreign presence represents the true degree of multinational presence in terms of employment. For our econometric investigation we alter this more standard foreign presence measure to present foreign presence in a county relative to that in other counties:

$$G\left(\frac{FP_{i,t-1}^{c}}{FP_{i,t-1}^{-c}}\right)=\frac{\dfrac{L_{i,t}^{f,c}}{L_{i,t}^{c}}}{\dfrac{L_{i,t}^{f,-c}}{L_{i,t}^{-c}}}$$

where $L_{i,t}^{f,c}$ represents total foreign employment in industry *i* and county *c* and $L_{i,t}^{c}$ is total employment in industry *i* in county *c*.

One limitation of this measure is that the spatial dimension is not present since it is only based on employment data. As noted by Ciccone and Hall (1996) and Ciccone (2002), the *density* of economic activity may be more suitable to capture possible externalities related to the agglomeration of economic activities through space. If space and location matter then we need to consider those in our measure of foreign firms related externalities. As a consequence, we will also use a measure of relative foreign employment density. Using non-agricultural counties' areas for the 27 counties of Ireland, the second measure of foreign presence based on relative foreign employment density may be expressed as:

$$G\left(\frac{FP_{i,t-1}^{c}}{FP_{i,t-1}^{-c}}\right)=\frac{\frac{L_{i,t}^{f,c}}{area^{c}}}{\frac{L_{i,t}^{f,-c}}{area^{-c}}}$$

where *area* is measured in square meters.

The *Forfás Employment Survey* only provides information on the employment level of each plant and hence we have to resort to an alternative plant level data source in order to estimate (11). In particular, we got access to the *Irish Economy Expenditure Survey*, which covers between 60 to 80 per cent of larger plants located in Ireland, and provides, amongst other things, the information necessary to estimate (11), namely the output, employment and wage level of each plant.[11] As a consequence, our foreign presence variable is an accurate measure of foreign presence in Irish counties while the panel of domestic firms for which equation (11) is only a sub-sample of the whole Irish manufacturing sector given the data limitations on our non-labor explanatory variables.

3.2 Econometric Issues

Simple OLS estimation of (11) would yield biased estimators given that one can expect the plant specific effects μ_j to be correlated with the error terms $\varepsilon_{j,t}$, that is, there may be some unobservable plant-specific effect likely to influence employment growth at the plant level. In order to remove the influence of those plant-specific effect we then first difference the expression given in (11). Still, additional problems have to be considered. First, one can consider that labor demand to be dynamic in nature so that employment growth at time *t* is likely to be influenced by employment growth at *t-1* because of adjustment process in plants' employment policy (see, for example, Hamermesh (1993) for a description of standard labor demand functions in a dynamic context). Second, we can reasonably suspect output and wage growth to be endogenous. The problem with using a dynamic approach is that it makes the estimation more complicated especially because the lagged dependent variable used on the right-hand side is necessarily correlated with the disturbance term. As noted by Greene (2000, p.583) one should then rely on Generalized Method of Moments (GMM) estimators. In particular, Arellano and Bond (1991)

[11] For a detailed description of this data set see the Data Appendix.

derived a GMM estimator to be estimated using lagged levels of the dependent variable and possibly endogenous explanatory variables as instruments. Our econometric test will be based on this method. The consistency of such estimator relies on the assumption of absence of first order serial correlation. If the disturbance are not serially correlated, there should be evidence of significant negative first order serial correlation in the differenced residuals but no evidence of second order serial correlation. Furthermore, the number of instrumental variables may become very large and the use of too many instruments may result into overfitting biases. As a consequence, when instrumenting the lagged dependent variable we chose unrestricted lags of the dependent variable as instruments (that is from *t-2* backward) while limiting the use of instruments up to four lags for the plant-specific variables. Sargan tests are conducted in order to check the validity of our instrument sets.

3.3 Empirical Results

As noted earlier, our main goal is to see whether there are advantages for domestic firms to co-locate with multinationals firms and whether this advantages translate into higher employment growth. Given that the results documented in the previous section showed that at least for half of the sectors in Irish manufacturing there was coagglomeration there seems to be at least indirect evidence for this. In table 6 we report some descriptive statistics on employment growth and the explanatory variables of the model described by equation (11) together with the average of the coagglomeration index over the period under scrutiny. We consider Nace 2 digit sectors for two reasons mainly. First because the previous evidence showed that co-location was more significant within broader categories of industries and we argued that this was probably due to the fact that externalities could arise through backward-forward linkages. As explained later, when trying to link the advantage of coagglomeration with employment growth of Irish domestic firms we will make use of those indices in order to study high and low coagglomeration sectors separately. The second reason is given by the restriction on the sample data. Since we only use a reduced (albeit representative) sample of Irish plants, many three digits sectors are likely to be underrepresented or even omitted if we use Nace 3 digit sectors in order to define foreign presence. For all these reasons, we then chose to work with Nace 2 digit sectors only.

3.3.1 General results

A first noticeable result from table 6 is that employment growth has been largely positive on average for domestic firms over the period considered here. Apart from a few traditional sectors like Drink and Tobacco, Textiles and Clothing, Footwear and Leather, all sectors display positive growth rates that are especially high in some hi-tech industries like Medical and Precision Instruments, Other Electrical Machinery and Apparatus Machinery and Equipment, Office Machinery and Computers, and Transport Equipment. For the last three sectors we also observe a positive coagglomeration index on average over the period. Wage growth has been important as well as output growth (except for the sector Drink and Tobacco) denoting a period of high activity for the domestic Irish manufacturing industry over the 1983-1999 period. Overall, this evolution is strikingly different from the experience of other OECD countries. Except for a few hi-tech sectors like the Computer or Pharmaceutical Industries, the manufacturing industries and manufacturing employment in particular have been shrinking over the last three decades in OECD countries. The Irish case is very special since it is now well-known that Irish manufacturing boom has largely been fostered by FDI (see for example, Barry and Bradley (1997), and Görg and Strobl (2002)). The question we tackle in what follows is to what extent agglomeration economies has played an active role in the dynamics of Irish manufacturing growth. To this end, in column 1 of table 7 we present the results of our estimation by testing equation (11). Results indicate that all explanatory variables except the lagged endogenous variable display the expected signs and are highly significant. More importantly, the relative foreign share displays a positive coefficient equal to 0.160 and is significant at the 5% confidence level which provides support for strong positive impact of coagglomeration on employment growth for domestic firms. That is, even after controlling for plant-level variables determining employment growth and for the general employment growth dynamics by manufacturing industry, *co-location between foreign and domestic plants has played a major role in explaining employment growth of the latter*. The preceding result means that there are specific advantages for domestic firms to locate close to foreign affiliates. From an econometric point of view, the general assumption lying behind the use of a dynamic panel data approach are validated by the different test statistics: the Wald test on the joint significance of non-dummy variables shows that our explanatory variables are highly significant, the Sargan test does not allow us to reject the hypothesis of validity of the set of instruments used while the AR (auto-correlation) provides

evidence for first but not second order serial correlation. Results including foreign employment density measure instead of foreign presence are depicted in column (2) of table 7. Despite displaying positive coefficient our measure is now no longer significant.

3.3.2 Checking for robustness

The previous results call for further robustness checks. First, the plant-specific variables of our model are measured in relative terms using country-level averages as reference. In order to check the robustness of our results we also took as reference the median firms for our non-foreign employment variables, those estimates are reported in columns (3)-(4) of table 7. We obtain similar results: relative foreign employment share still display a positive and significant (at 10% significance level) coefficient but the result does not hold for the foreign employment density variable.

Second, up to now we assumed that potential spillovers were essentially sector-specific. That is naturally due to our previous discussion based on the Ellison and Glaeser index where such hypothesis may be partially relaxed using the coagglomeration index in order to capture within-broad industries externalities. However, following Jacobs' view, externalities may arise from the diversity of sectors present in a given region. Our measure of FDI-related spillovers does not take into account this kind of effect. In order to do so, we also included as explanatory variable the relative foreign presence in the rest of sectors, that is, sectors to which each plant *j* do not belong. Results of such estimations are reported in columns (5) and (6) of table 7 and remain broadly similar to the previous ones. In addition, there is no evidence of inter-industry externalities.

Third, it must be recognized that the nature of our results may be influenced by possible selection bias. One could, for example, have negative instead of positive spillovers that dominate and push domestic firms to exit the market. Those domestic firms that remain on the market may hire part of the labor made available, the result being a positive correlation between foreign presence or density and local firms employment growth. In order to, at least partially, control for this possibility, we also tested our equation keeping those firms that were continuously present over the 1983-1998 period in Ireland. Table 8 show that results are very similar to those presented in table 7, that is, relative foreign employment share display a positive and significant

coefficient (*0.136****) while foreign employment density coefficient is also positive but not significant (*0.113*).

Fourth, we have assumed so far that externalities occurred within a year since foreign presence is measured with a lag *t-1*. This can be too restrictive. In order to check whether there may exist persistent effects of foreign presence through time we also include further lags of this variable in a way similar to de Lucio *et al.* (2002). Only results for the coefficients of the four foreign presence variables are reported in table 9.[12] In addition, we had to restrict the number of lags used up to five years in order to maintain a feasible sample size. We observe that the significant effect of foreign presence mainly occur within a year and vanishes afterwards. However, we now obtain a significant coefficient on foreign employment density while no inter-industry spillovers seem to take place.

3.3.3 Coagglomeration and growth

Until now we have not related our econometric results with the observation that, in Ireland, domestic firms have largely been coagglomerating with foreign firms. The results presented in the previous section provide strong evidence in this direction. Our approach, following Ellison and Glaeser (1997) mainly relies on the assumption that the potential externalities related to the agglomeration of economic activities are mainly sector-specific. Our basic hypothesis in this paper is that for some sectors, externalities related to backward-forward linkages, labor market pooling or technological externalities for example are amplified by the presence of foreign affiliates. One can then reasonably expect that the positive link between coagglomeration and growth to be especially important for those sectors where the coagglomeration index is positive. Put differently, if there is an advantage for domestic plants to co-locate with foreign firms then this advantage must translate into higher growth rates. We then re-estimated equation (11) splitting our sample of domestic firms into two groups according to the descriptive statistics displayed in table 6 depending on their average of coagglomeration index. The results of this exercise are included in table 10. The results are now strikingly

[12] Alternatively, sectors were classified according to frequence of the sign of the coagglomeration index. Results were identical to the ones presented here.

different between the two groups of sectors. As shown in columns (1) and (3) of table 10, for highly co-agglomerated sectors we obtain a positive and significant coefficient that is equal to 0.106 and significant at 10% for the foreign employment share variable, which is in line with our previous evidence but moreover, the foreign density coefficient turns out to be positive and significant (*0.154***) which gives support to the results obtained in table 9. Including now foreign presence in the rest of sectors as in columns (2) and (4) we obtain a positive and significant coefficient for foreign share (*0.460**) but not for foreign density (*-0.059*). For non-coagglomerated sectors, none of these variable were significant.

4. *Summary and Conclusion*

It is now widely accepted that the astonishing economic performance of the Irish economy over the last decade has in a large part been due to the considerable influx of FDI. One of the major objectives of Irish policy makers in attracting FDI has been to stimulate the development of the domestic sector through spillovers from multinationals. According to the New Economic Geography literature such spillovers are often better fostered if plants are located close to each other. In this paper we have thus investigated what role the spatial coagglomeration of domestic and foreign plants has played toward the local industrial development.

Using an index recently developed by Ellison and Glaeser (1997) we have first shown that for a large number of sectors coagglomeration between domestic and foreign plants has been considerable and persistent, and has coincided with the influx of FDI since the early 1970s. In order to verify that coagglomeration has served to stimulate indigenous industrial development we have estimated plant-level employment growth equations allowing for potential foreign presence spillovers. Our results support the existence of positive *local* spillovers from multinationals on indigenous employment growth. Dividing our sample into sectors with different coagglomeration experiences we find that such spillovers only take place for industries where there has been considerable coagglomeration of domestic and foreign plants over the 1983-1998 period.

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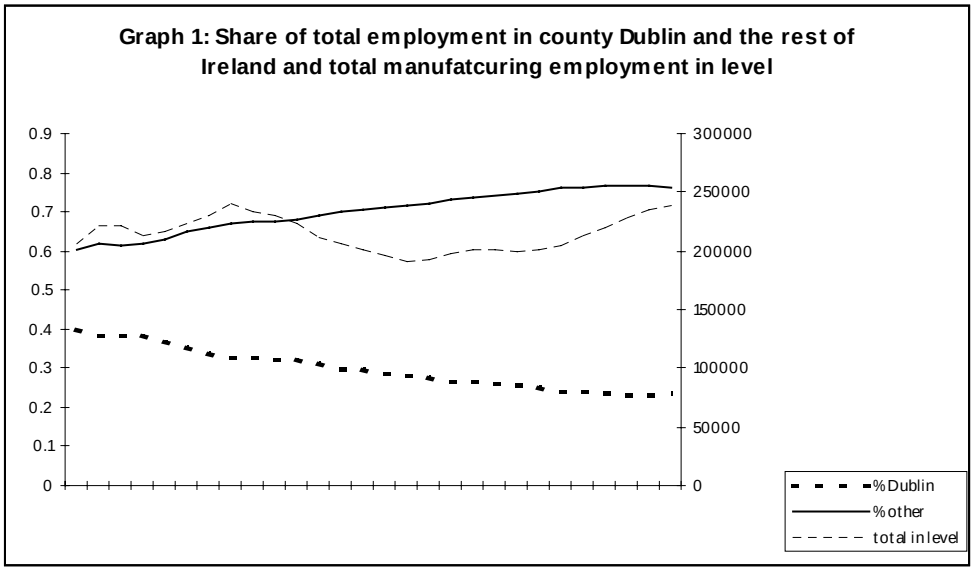
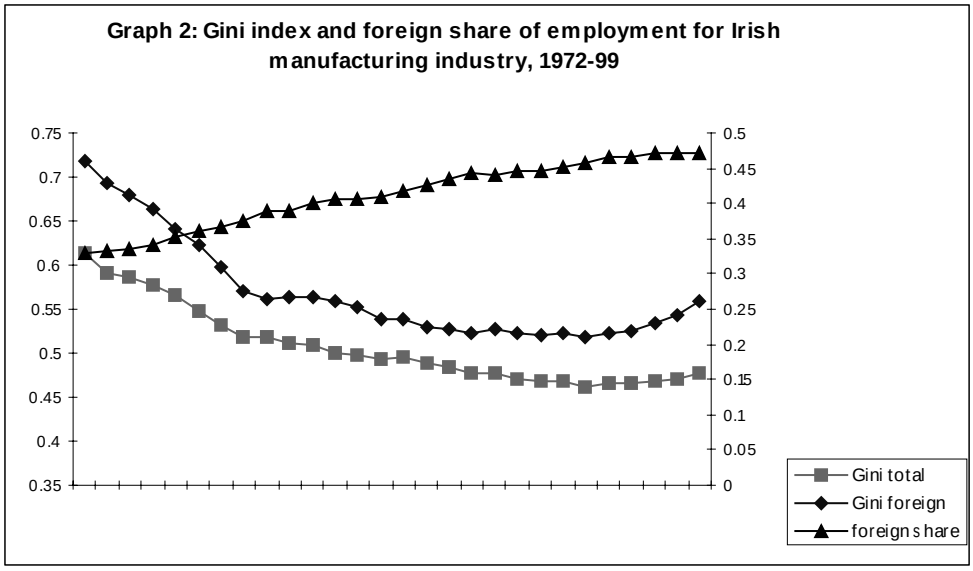
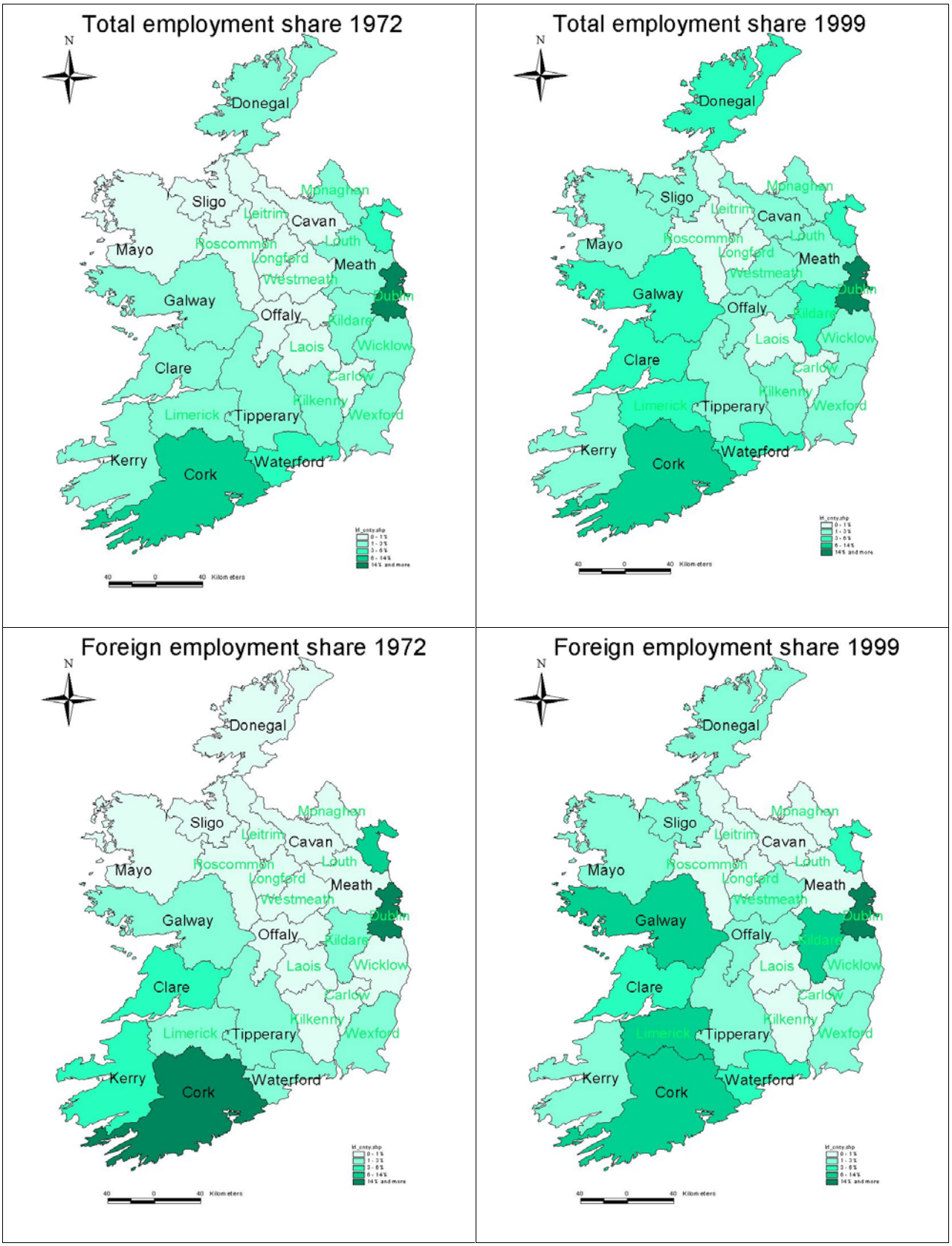
Graphs, maps and Tables



Notes: right hand-side scale applies to foreign share
Left hand-side scale is for the Gini index



Notes: right hand-side scale applies to total employment level
Left hand-side scale applies to foreign employment share in Ireland


Total employment share 1972
Donegal
Sligo
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Cavan
Monaghan
Mayo
Roscommon
Longford
Louth
Meath
Westmeath
Dublin
Galway
Offaly
Kildare
Laois
Wicklow
Clare
Carlow
Kilkenny
Limerick
Tipperary
Wexford
Kerry
Cork
Waterford
Total employment share 1999
Donegal
Sligo
Leitrim
Cavan
Monaghan
Mayo
Roscommon
Longford
Louth
Meath
Westmeath
Dublin
Galway
Offaly
Kildare
Laois
Wicklow
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Limerick
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Cork
Waterford
Foreign employment share 1972
Donegal
Sligo
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Foreign employment share 1999
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Carlow
Kilkenny
Limerick
Tipperary
Wexford
Kerry
Cork
Waterford

Table 1 : Distribution of total and foreign employment by county of Ireland, 1972-1999 (%)

	Pop. share [§]	Total employment					Foreign employment				
		1972	1983	1999	Δ7283	Δ8399	1972	1983	1999	Δ7283	Δ8399
Carlow	1.15	1.24	1.88	1.49	0.64	-0.39	0.11	1.57	1.04	1.46	-0.53
Cavan *	1.46	1.26	1.95	1.93	0.69	-0.02	0.60	1.41	1.07	0.82	-0.34
Clare *	2.59	2.55	3.24	3.53	0.69	0.29	3.97	5.28	5.45	1.31	0.17
Cork *	11.60	14.31	12.37	12.94	-1.94	0.56	14.74	12.61	13.93	-2.13	1.32
Donegal *	3.58	2.41	2.80	3.60	0.39	0.80	1.28	2.47	2.99	1.19	0.53
Dublin	29.18	39.84	31.00	23.56	-8.84	-7.45	44.26	31.17	21.87	-13.08	-9.30
Galway *	5.21	2.36	3.65	5.80	1.29	2.16	2.38	4.51	6.90	2.13	2.38
Kerry *	3.48	1.61	2.38	2.29	0.77	-0.09	3.77	3.21	2.14	-0.56	-1.07
Kildare	3.72	2.59	2.61	5.03	0.02	2.42	2.32	2.16	7.46	-0.16	5.30
Kilkenny	2.08	1.62	1.74	1.56	0.12	-0.18	0.47	0.72	0.42	0.25	-0.30
Laois	1.46	0.92	1.32	0.71	0.40	-0.61	0.46	1.22	0.37	0.76	-0.84
Leitrim *	0.69	0.35	0.64	0.56	0.29	-0.09	0.17	0.68	0.56	0.50	-0.12
Limerick	4.55	2.30	4.67	6.35	2.36	1.68	3.49	6.45	8.90	2.96	2.45
Longford *	0.83	0.52	1.18	0.94	0.66	-0.24	0.43	1.23	0.46	0.80	-0.77
Louth	2.54	5.60	4.22	3.59	-1.38	-0.63	8.44	5.04	3.67	-3.40	-1.37
Mayo	3.08	1.48	2.43	2.58	0.95	0.15	0.96	3.40	2.86	2.44	-0.55
Meath	3.03	2.12	2.20	2.25	0.08	0.05	1.30	1.59	1.10	0.30	-0.49
Monaghan *	1.42	1.68	1.86	2.07	0.18	0.21	1.05	0.62	0.52	-0.43	-0.10
Offaly	1.63	1.27	1.33	1.85	0.06	0.53	0.15	1.09	1.96	0.94	0.87
Roscommon *	1.43	0.50	0.96	1.31	0.46	0.35	0.14	0.52	1.13	0.38	0.61
Sligo *	1.54	1.21	1.35	1.78	0.14	0.44	1.39	1.64	2.36	0.25	0.72
Tipperary N. Riding	1.60	0.64	1.55	1.71	0.91	0.16	0.69	1.11	1.00	0.42	-0.11
Tipperary S. Riding	2.08	1.86	2.23	1.77	0.36	-0.45	1.25	1.99	1.79	0.73	-0.19
Waterford	2.61	4.26	4.44	4.19	0.18	-0.26	2.41	3.01	4.47	0.60	1.46
Westmeath	1.75	0.98	1.30	1.58	0.32	0.28	0.93	1.77	1.89	0.84	0.12
Wexford	2.88	2.20	2.36	2.51	0.16	0.14	1.71	1.99	1.99	0.28	0.00
Wicklow	2.83	2.33	2.35	2.52	0.03	0.17	1.14	1.53	1.70	0.39	0.17

Note : Source Forfás, CSO and authors' computations.

[§] population share refers to year 1996.

Counties followed by * are designated areas. County Cork is only partly a designated area.

Table 2 : Distribution of foreign plants start-up by group of county, 1972-1999

	1972-1983				1984-1999			
Countries of origin	**non-disadv. areas**	**disadv. areas**	**Greater Dublin***	**total**	**non-disadv. areas**	**disadv. areas**	**Greater Dublin***	**total**
USA	112	88	58	258	106	79	66	251
Japan	5	2	10	17	10	6	9	25
Germany	38	57	12	107	36	57	12	105
Great Britain	60	57	55	172	35	51	28	114
Other EU	66	50	16	132	39	56	19	114
Other non EU	23	16	16	55	16	19	16	51
Total	304	271	169	741	242	269	152	660
distribution in %	*0.41*	*0.36*	*0.23*	*1.00*	*0.37*	*0.41*	*0.23*	*1.00*

Sources : Forfás and authors' computations

* includes Dublin, Kildare and Meath.

Table 3: Coagglomeration index for Irish manufacturing sectors, 1972-1999

Sector Nace 3 digits	CEG1972	CEG1985	CEG1999	var.72-85	var.85-99
151.Production processing and meat products	0.047	0.058	0.027	+	-
152.Processing and preserving of fish and fish products	0.091	0.099	0.040	+	-
153.Processing and preserving of fruit and vegetables	-0.123	-0.039	0.117	+	+
155.Dairy products	0.106	0.071	0.044	-	-
157.Prepared animal feeds	-0.237	0.049	0.014	+	-
158.Other food products	0.007	-0.009	0.015	-	+
159.Beverages	-0.077	-0.045	-0.030	+	+
160.Tobacco products	-0.270	0.000	-0.126	+	+
171.Preparation and spinning of textile fibres	0.027	0.019	0.238	-	+
174.Made-up textile articles except apparel	-0.004	0.010	-0.005	+	-
175.Other textiles	0.264	0.076	-0.005	-	-
177.Knitted and crocheted articles	0.008	0.101	0.174	+	+
182.Other wearing apparel and accessories	-0.024	0.044	0.005	+	-
191.Tanning and dressing of leather	0.024	0.014	0.023	-	+
201.Sawmilling and planing of wood; impregnation of wood	0.092	0.101	0.040	+	-
211.Pulp paper and paperboard	0.105	0.173	0.218	+	+
222.Printing and service activities related to printing	0.151	0.199	0.189	+	-
241.Basic chemicals	-0.105	0.012	-0.034	+	-
243.Paints varnishes and similar coatings printing ink and mastics	0.174	0.098	0.120	-	+
244.Pharmaceuticals medicinal chemicals and botanical products	-0.011	-0.034	-0.014	-	+
245.Soap and detergents cleaning and perfumes	0.308	0.015	0.005	-	-
246.Other chemical products	0.078	0.077	0.021	-	-
251.Rubber products	0.096	0.001	0.008	-	+
252.Plastic products	-0.015	0.006	0.006	+	+
261.Glass and glass products	0.129	0.160	-0.007	+	-
262.Non-refractory ceramic goods other than for construction purposes;	0.193	0.085	0.092	-	+
264.Bricks tiles and construction products in baked clay	0.015	0.043	0.047	+	+
266.Articles of concrete plaster and cement	0.005	0.038	0.034	+	-
268.Other non-metallic mineral products	0.011	0.186	-0.048	+	-
281.Structural metal products	-0.087	-0.018	-0.019	+	-
282.Tanks reservoirs and containers of metal; central heating radiators	0.135	-0.029	-0.010	-	+
287.Other fabricated metal products	-0.002	-0.009	0.002	-	+
292.Other general purpose machinery	-0.206	-0.017	0.021	+	+
295.Other special purpose machinery	-0.004	-0.016	-0.002	-	+
297.Domestic appliances n.e.c.	0.023	-0.001	0.012	-	+
300.Office machinery and computers	0.099	0.023	-0.014	-	-
311.Electric motors generators and transformers	-0.025	-0.066	-0.023	-	+
313.Insulated wire and cable	0.132	-0.052	-0.050	-	+
315.Lighting equipment and electric lamps	0.022	-0.101	-0.015	-	+
316.Electrical equipment n.e.c.	-0.154	0.099	0.018	+	-
322.Television and radio transmitters and apparatus	0.258	-0.012	0.018	-	+
331.Medical and surgical equipment and orthopaedic appliances	0.063	-0.034	-0.049	-	-
332.Instruments and appliances for measuring checking testing navigating	0.281	0.016	-0.029	-	-
334.Optical instruments and photographic equipment	-0.097	-0.144	-0.155	-	-
343.Parts and accessories for motor vehicles and their engines	-0.012	0.015	0.031	+	+
361.Furniture	-0.053	-0.087	0.012	-	+
362.Jewellery and related articles	0.129	-0.108	-0.111	-	-
365.Games and toys	-0.016	-0.045	0.090	-	+
366.Miscellaneous manufacturing n.e.c.	-0.015	-0.007	0.007	+	+
Averages for all sectors	0.031	0.021	0.019		
Spearman rank correlation coefficients	**1972-85**	**1985-99**	**1972-99**		
Nace 3 digits	0.351	0.516	0.157		
	(0.013)	(0.000)	(0.281)		
Nace 2 digits	0.437	0.674	0.232		
	(0.070)	(0.002)	(0.353)		

Note: * P-values between parentheses

Table 4: CEG transition matrices

1972-1999

Nace 3 digits

1-year	<0	>0	Total
<0	91.09	8.91	100
>0	7.34	92.66	100
Total	45.15	54.85	100
5-years	<0	>0	Total
<0	79.56	20.44	100
>0	19.51	80.49	100
Total	46.84	53.16	100

Nace 2 digits

1-year	<0	>0	Total
<0	90.48	9.52	100
>0	5.36	94.64	100
Total	38.1	61.9	100
5-years	<0	>0	Total
<0	70.73	29.27	100
>0	15.63	84.38	100
Total	37.14	62.86	100

1972-1983

Nace 3 digits

1-year	<0	>0	Total
<0	92.01	7.99	100
>0	7.25	92.75	100
Total	42.73	57.27	100
5-years	<0	>0	Total
<0	76	24	100
>0	20.59	79.41	100
Total	44.07	55.93	100

Nace 2 digits

1-year	<0	>0	Total
<0	91.49	8.51	100
>0	4.38	95.62	100
Total	39.83	60.17	100
5-years	<0	>0	Total
<0	73.68	26.32	100
>0	13.04	86.96	100
Total	40.48	59.52	100

1984-1999

Nace 3 digits

1-year	<0	>0	Total
<0	90.36	9.64	100
>0	7.1	92.9	100
Total	46.65	53.35	100
5-years	<0	>0	Total
<0	75.28	24.72	100
>0	17.58	82.42	100
Total	46.11	53.89	100

Nace 2 digits

1-year	<0	>0	Total
<0	90.74	9.26	100
>0	6.45	93.55	100
Total	37.41	62.59	100
5-years	<0	>0	Total
<0	71.43	28.57	100
>0	25	75	100
Total	40.48	59.52	100

Table 5: Employment growth and foreign presence by county of Ireland, 1972-1999

	Total employment		Domestic employment		Foreign share in total employment				
	growth 1972-83	growth 1983-99	growth 1972-83	growth 1983-99	1972	1983	1999	Δ72-83	Δ83-99
Carlow	0.55	-0.10	0.05	-0.09	0.03	0.34	0.33	0.31	-0.01
Cavan *	0.58	0.12	0.32	0.17	0.16	0.29	0.26	0.14	-0.03
Clare *	0.30	0.23	-0.09	-0.01	0.51	0.66	0.73	0.15	0.07
Cork *	-0.12	0.18	-0.22	-0.01	0.34	0.41	0.51	0.07	0.09
Donegal *	0.19	0.45	-0.08	0.37	0.17	0.36	0.39	0.18	0.03
Dublin	-0.20	-0.14	-0.26	-0.18	0.37	0.41	0.44	0.04	0.03
Galway *	0.58	0.80	0.18	0.59	0.33	0.50	0.56	0.17	0.06
Kerry *	0.51	0.09	2.01	0.35	0.77	0.55	0.44	-0.22	-0.11
Kildare	0.03	1.18	-0.03	-0.01	0.30	0.34	0.70	0.04	0.36
Kilkenny	0.10	0.01	0.01	0.06	0.10	0.17	0.13	0.07	-0.04
Laois	0.47	-0.39	0.10	-0.27	0.17	0.38	0.25	0.21	-0.13
Leitrim *	0.88	-0.02	0.28	-0.10	0.16	0.43	0.47	0.27	0.04
Limerick	1.07	0.54	0.82	0.19	0.50	0.56	0.66	0.06	0.10
Longford *	1.34	-0.10	0.86	0.20	0.28	0.42	0.23	0.15	-0.19
Louth	-0.23	-0.04	-0.21	-0.03	0.50	0.48	0.48	-0.01	0.00
Mayo	0.68	0.20	-0.08	0.33	0.21	0.57	0.52	0.35	-0.05
Meath	0.06	0.15	-0.06	0.26	0.20	0.29	0.23	0.09	-0.06
Monaghan *	0.13	0.26	0.23	0.28	0.21	0.13	0.12	-0.07	-0.02
Offaly	0.07	0.58	-0.26	0.19	0.04	0.33	0.50	0.30	0.16
Roscommon *	0.97	0.54	0.70	0.18	0.09	0.22	0.40	0.13	0.19
Sligo *	0.14	0.50	-0.07	0.11	0.38	0.49	0.62	0.12	0.13
Tipperary North Riding	1.48	0.25	1.75	0.28	0.36	0.29	0.28	-0.07	-0.02
Tipperary South Riding	0.22	-0.10	0.00	-0.26	0.22	0.36	0.48	0.14	0.11
Waterford	0.07	0.06	-0.05	-0.27	0.19	0.28	0.50	0.09	0.23
Westmeath	0.35	0.38	-0.12	0.35	0.31	0.55	0.56	0.24	0.01
Wexford	0.10	0.20	-0.03	0.14	0.26	0.34	0.38	0.09	0.03
Wicklow	0.03	0.21	-0.09	0.12	0.16	0.26	0.32	0.10	0.05
Total Ireland	0.02	0.13	-0.09	0.01	0.33	0.41	0.47	0.08	0.07

Note: Counties followed by * are designated areas. County Cork is only partly a designated area.

Table 6: Descriptive statistics: growth, foreign presence and coagglomeration, 1983-1998.

	Average employ. growth*	Average wage growth*	Average output growth*	# domestic firms	# foreign firms	Average foreign presence	Average CEG. index	Std. Dev. CEG
15. Food	1.4	2.5	5.6	977	72	16.7	-0.039	0.006
16. Drink and Tobacco	-0.5	-5.8	-2.3	72	30	48.0	-0.032	0.007
17. Textiles	-0.1	3.1	3.9	324	52	41.4	0.055	0.018
18. Clothing, footwear and leather	-3.1	2.8	3.3	440	49	21.6	0.019	0.014
20. Wood and product of wood exc. furniture	3.8	2.5	7.0	400	8	3.9	0.024	0.017
21. Pulp, paper and paper products	2.2	4.8	7.4	92	14	18.4	0.140	0.022
22. Publishing, printing and recorded media	1.2	2.8	5.7	337	13	7.0	0.170	0.018
24. Chemicals and chemicals products	3.2	1.7	4.5	173	124	65.6	0.009	0.003
25. Rubber and plastic products	2.6	4.1	6.4	231	65	33.4	0.004	0.003
26. Other non-metallic mineral products	2.4	3.2	7.3	478	34	15.3	-0.002	0.007
28. Basic and fabricated metal products	2.7	3.6	8.7	927	95	22.5	-0.006	0.002
29. Machinery and equipment	4.1	5.7	8.5	305	52	36.9	0.027	0.006
30. Office machinery and computers	9.1	2.9	19.0	56	63	71.6	0.013	0.017
31. Electrical machinery and apparatus, nec.	5.6	2.3	11.5	178	63	51.0	-0.011	0.017
32. Electronic equipment	1.6	1.7	10.3	59	39	59.8	-0.006	0.008
33. Medical and precision instruments	6.8	0.5	11.0	107	66	60.6	-0.028	0.008
35. Transport equipment	7.4	4.2	13.6	198	43	38.2	0.012	0.033
37. Other manufacturing industries nec.	2.1	2.8	8.8	937	30	12.0	0.001	0.005

Note:
* for domestic firms only

Table 7: General results. Dependent variable: employment growth by domestic plants in Ireland, 1983-1998

	(1)	(2)	(3)	(4)	(5)	(6)
Employment growth (t-1)	-0.010	-0.000	-0.005	0.003	-0.013	-0.008
	(0.028)	(0.030)	(0.029)	(0.030)	(0.029)	(0.031)
Output growth (t)	0.257***	0.264***	0.259***	0.267***	0.250***	0.260***
	(0.067)	(0.067)	(0.066)	(0.066)	(0.067)	(0.066)
Wage growth (t)	-0.360***	-0.368***	-0.368***	-0.393***	-0.353***	-0.371***
	(0.090)	(0.095)	(0.088)	(0.096)	(0.091)	(0.096)
Growth sector (t)	0.401***	0.398**	0.381***	0.367**	0.424***	0.400**
	(0.150)	(0.160)	(0.136)	(0.151)	(0.162)	(0.159)
Foreign share sector (t-1)	0.160**	-	0.142*	-	0.168**	-
	(0.081)		(0.086)		(0.084)	
Foreign density sector (t-1)	-	0.102	-	0.053	-	0.090
		(0.106)		(0.130)		(0.111)
Foreign share manuf. (t-1)	-	-	-	-	0.255	-
					(0.332)	
Foreign density manuf. (t-1)	-	-	-	-	-	0.052
						(0.720)
# obs.	5192	5192	5192	5192	5192	5192
Wald (joint)	50.05**	43.90**	52.20**	47.90**	53.43**	44.83**
p-value	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Sargan	177.1	182.8	176.7	182.7	175.5	175.0
p-value	[0.142]	[0.086]	[0.147]	[0.087]	[0.148]	[0.154]
AR(1) test	-10.07**	-10.58**	-10.03**	-10.62**	-9.892**	-10.45**
p-value	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
AR(2) test	-1.424	-1.436	-1.665	-1.565	-1.431	-1.427
p-value	[0.154]	[0.151]	[0.096]	[0.117]	[0.152]	[0.154]

Notes:
Equations (1)-(2) and (5)-(6) use deviation with respect to the mean-values of the variables in the rest of the country. Equations (3)-(4) use deviations with respect to the medians. All specifications include a constant term together with time and sector dummies. Two-steps, heteroskedasticity-consistent standard error in parentheses. The Wald test is performed on the explanatory variables, excluding the time and sector dummies. Wald, Sargan and AR tests are based on two-step heteroskedastic estimate. Probability-values are in parentheses for those tests.

Table 8: Continuous plants only. Dependent variable: employment growth by domestic plants in Ireland, 1983-1998

	(1)	(2)
Employment growth (t-1)	0.002	-0.001
	(0.03)	(0.033)
Output growth (t)	0.184**	0.183**
	(0.074)	(0.077)
Wage growth (t)	-0.313***	-0.307***
	(0.092)	(0.095)
Growth sector (t)	0.496***	0.475***
	(0.161)	(0.161)
Foreign share sector (t-1)	0.136**	-
	(0.058)	
Foreign density sector (t-1)	-	0.113
		(0.106)
Foreign share manuf. (t-1)	0.368	-
	(0.335)	
Foreign density manuf. (t-1)	-	0.124
		(0.676)
# obs.	3984	3984
Wald (joint)	26.69**	23.51**
p-value	[0.000]	[0.001]
Sargan	149.3	152.8
p-value	[0.658]	[0.580]
AR(1) test	-8.150**	-8.072**
p-value	[0.000]	[0.000]
AR(2) test	-0.827	-0.937
p-value	[0.408]	[0.349]

Table 9: Introducing dynamics. Dependent variable: employment growth by domestic plants in Ireland, 1983-1998

	Lag (t-1)	Lag (t-2)	Lag (t-3)	Lag (t-4)
Foreign share sector	0.270**	0.075	0.050	0.102
	(0.103)	(0.098)	(0.091)	(0.063)
Foreign share manuf.	0.491	0.238	-0.261	0.554
	(0.457)	(0.534)	(0.457)	(0.500)
Foreign density sector	0.283**	0.065	0.039	0.040
	(0.112)	(0.114)	(0.108)	(0.109)
Foreign density manuf.	-0.637	1.328	-1.309	-0.332
	(1.269)	(1.298)	(1.243)	(1.114)

Notes:
Only foreign share and foreign density variables are presented. Other explanatory variables were also used as in table 4 but are not reported for clarity. The same applies to different statistical tests. Regressions were run using continuing plants only.

Table 10: Dependent variable: employment growth by domestic plants in Ireland, 1983-1998

	positive coagglomeration sectors				*negative coagglomeration sectors*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
employment growth (t-1)	-0.01	-0.015	-0.019	-0.02	-0.009	-0.001	-0.013	-0.17
	(0.041)	(0.042)	(0.041)	(0.042)	(0.032)	(0.033)	(0.032)	(0.035)
output growth (t)	0.135**	0.138**	0.143**	0.144**	0.319***	0.322***	0.317**	0.318***
	(0.065)	(0.652)	(0.06)	(0.062)	(0.090)	(0.088)	(0.087)	(0.085)
wage growth (t)	-0.341***	-0.327***	-0.358***	-0.359***	-0.345***	-0.350***	-0.345***	-0.347***
	(0.074)	(0.080)	(0.072)	(0.072)	(0.093)	(0.090)	(0.096)	(0.094)
growth sector (t)	0.387**	0.433***	0.380***	0.375***	0.688***	0.688***	0.665***	0.664***
	(0.126)	(0.122)	(0.130)	(0.126)	(0.207)	(0.204)	(0.201)	(0.202)
foreign share sector (t-1)	0.106*	0.111*	-	-	-0.078	-0.055	-	-
	(0.060)	(0.06)			(0.087)	(0.096)		
foreign density sector (t-1)	-	-	0.154**	0.155**	-	-	-0.279	-0.191
			(0.062)	(0.07)			(0.354)	(0.35)
foreign share manuf. (t-1)	-	0.460*	-	-		0.539		-
		(0.263)				(0.537)		
foreign density manuf. (t-1)	-	-	-	-0.059		-		-0.499
				(0.642)				(0.914)
# obs.	2511	2511	2511	2511	2681	2681	2681	2681
Wald	62.69**	73.31**	66.09**	66.62**	44.95**	50.63**	45.94**	46.48**
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Sargan	170.1	164.4	172.4	172.0	175.5	171.3	173.0	171.3
	[0.241]	[0.327]	[0.205]	[0.196]	[0.161]	[0.206]	[0.197]	[0.207]
AR(1) test	-6.870**	-7.062**	-7.109**	-7.058**	-8.219**	-8.046**	-8.307**	-8.382**
	[0.000]	[0.00]	[0.000]	[0.00]	[0.000]	[0.000]	[0.000]	[0.000]
AR(2) test	-0.970	-0.988	-1.155	-1.161	-1.198	-1.171	-1.275	-1.287
	[0.332]	[0.323]	[0.248]	[0.246]	[0.231]	[0.242]	[0.202]	[0.198]

Notes:
All specifications include a constant term together with time and sector dummies. Two-steps, heteroskedasticity-consistent standard error in parentheses. The Wald test is performed on the explanatory variables, excluding the time and sector dummies. Wald, Sargan and AR tests are based on two-step heteroskedastic estimates. Probability-values are in parentheses for those tests.

Data appendix

Forfás Employment Survey
This is an annual plant level survey collected by *Forfás*, the policy and advisory board for industrial development in Ireland, since 1972, and we have access to this data up until and including the year 2000. The response rate to this survey is argued by *Forfás* to essentially be nearly 100 per cent, i.e., our data can be seen as including virtually the whole population of manufacturing plants in Ireland. Information at the plant level include time invariant variables such as the nationality of ownership, sector of production, and detailed regional location of each plant, as well as the level of employment in each year. *Forfás* defines foreign plants as plants which are majority-owned by foreign shareholders, i.e., where 50 per cent or more of the shares are owned by foreign shareholders. While arguably, plants with lower foreign ownership should possibly still be considered foreign owned, this is not necessarily a problem for the case of Ireland since almost all foreign direct investment in Ireland has been Greenfield investment rather than acquisition of local firms (see Barry and Bradley, 1997). We use this data source to examine general employment trends and to construct our foreign presence variables.

Irish Economy Expenditure Survey
This is an annual plant level survey collected by *Forfás* since 1983, and we have access to this data up until and including the year 1998. Information is collected from larger plants, earlier in the data set of plants of at least 30 and since 1990 of firms of at least 20 employees, although it must be noted that a plant, once included, is generally still surveyed even if its employment level falls below the initial cut-off point. The response rate ranges on average from between 60 and 80 per cent. Information provided at the plant level, are amongst other things, the time invariant identifiers as for the *Forfás Employment Survey*, output, wages, and the employment level. We use these data for our econometric analysis, except for construction of the foreign presence variable.