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Multinationals' location choice, agglomeration economies and public incentives

By S. Barrios, H. Görg and E. Strobl

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Abstract

We study the regional location of multinationals in Ireland since the 1970s by focusing on the role played by agglomeration economies and public incentives intent on dispersing industrial activity to the more disadvantaged areas of Ireland. We find that regional policy has only been effective in attracting low-tech firms to the disadvantaged areas during the time when there was a much more laissez-faire approach to regional policy and when the primary industrial policy emphasis was on attracting high-tech firms into Ireland in general. Our results also show that hi-tech firms spread more evenly across the country and that urbanization economies were for these firms a more important locational determinant than public incentives.

JEL classification: F23, R38

Keywords: multinational location, agglomeration economies, public incentives, regional policy, nested logit

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Non-Technical Summary

In the present paper we study how regional policy and economies of agglomeration have affected the location of multinational firms within the Republic of Ireland. Ireland provides us a with a rich institutional backdrop within which to analyse the issues at hand given that there has been interventionist regional industrial policy in Ireland for over 50 years, with some important changes over time. Ireland's industrial policy is probably best known for its ability to attract, through generous tax relief and grant assistance, high performance, hi-tech multinationals that have been the driving force behind its economic success since the early 1990s. Importantly, however, Irish industrial policy makers have always ensured, by offering various regionally differentiated incentive schemes, that these interventionist tools have contained a strong regional component in order to attempt to disperse incoming industrial activity to its less advantaged regions.

While the importance of multinational companies for the Irish economy has been analysed in the recent literature there does not appear to be any in-depth analysis of the location patterns of MNCs. In this paper we utilise exhaustive plant level data of manufacturing plants in Ireland between 1973 and 1998 in order to trace the location of all multinationals over the period and estimate the determinants of their location choice using a rich set of potentially important explanatory variables. To this end we employ the nested logit model which proves to be particularly appropriate given that we are able to analyse location decisions by grouping location alternatives into regions that were explicitly defined by policy. Also, by distinguishing set ups of plants in hi-tech and low-tech industries we attempt to examine whether the determinants of multinationals' location choices in general differ in the presence of potential knowledge-related externalities and differential sectoral regional policy.

From our empirical analysis we find that regional policy has been an effective tool in promoting the location of foreign plants in disadvantaged counties, but only for low-tech firms since the mid-1980s when a much more *laissez-faire* approach to regional policy was introduced and policy makers were less (relatively to the earlier period) intent on dispersing high-tech firms. A closer look at the role played by agglomeration economies as determinants of firms' location shows that urbanization economies have been important for the location decision of high-tech multinationals since the mid 1980s while localization economies had no effect. This result corresponds to the view that high-value added and innovative industries first

locate in urban centers in order to avail of knowledge-related spillovers from the diversity of industries.

1 Introduction

Several authors have shown that elements such as increasing returns, market failures and spatial competition under strategic interactions may favor the rise of industrial clusters, see Fujita and Thisse (1996). Following this literature, small accidents or some natural advantages may foster the birth and rise of an industry in a particular location. The location of production may thus follow a cumulative causation process if agglomeration economies are to arise since start-up firms may tend to locate in existing industrial centres, increasing in turn the relative attractiveness of these through a circular process. If factor mobility is low, inequalities between regions with different industrial development may rise dramatically, compromising the development prospects of the less attractive regions, see Fujita and Thisse (2002). As a consequence, there may be scope for public intervention in order to alter the long run distribution of economic activity and to reduce spatial economic inequalities.

One should note, however that not all industries are subject to the same economies of agglomeration nor that such agglomeration forces determine industries' location identically. Some authors have put much emphasis on industries' characteristics in order to explain the spatial structure of economic activity. In particular, Henderson (1974) shows theoretically that cities' size and specialization vary if different products involve different levels of economies of scale. Henderson's view can also be related with the *Marshall-Arrow-Romer* (*MAR*) argument according to which the existence of increasing returns and learning by doing causes industries to concentrate in particular areas, see Glaeser et al. (1992). These kinds of externalities are industry-specific and are often termed *economies of localization* (or *specialization*). Agglomeration economies are not only industry-specific, however. According to Jacobs' (1969) view, there are also potential gains from urban diversity related to the cross-fertilization of ideas. In particular Henderson (1988) has shown that economies of localization and economies of urbanization have not the same influence on industries' location according to the type of industry one considers. Mature (or traditional) industries will tend to locate in regions where economies of localization dominate while modern (or hi-tech) industries and business services locate in highly urbanized areas. Making such a distinction, Henderson et al. (1995) have found empirically that only localization economies mattered for traditional industries' growth. In turn, for modern industries, both localization and urbanization economies were important. Other authors have shown that

urban diversity is especially important in determining hi-tech firms' location decision and that this, in turn, drives innovative activities to be geographically localized, see for example Jaffe et al. (1993), Feldman and Florida (1994), Audretsch and Feldman (1996) and Feldman and Audretsch (1999).

One could easily argue, however, that, despite their importance, both *MAR* and Jacobs' externalities are rather broad notions that are difficult to identify and hence, the influence of public incentives on firms' location decisions is not easy to assess. For example, from an urban economics perspective, Anas et al. (1998) conjecture that public intervention may have positive as well as negative side effects given that space-related externalities are only partially understood. Despite this, regional policy has been widely used, especially in the European Union, in order to boost the development of the poorest areas and to lower income disparities between regions, see Puga (2002). In effect, since economic growth is a local phenomenon, one could reasonably claim that the aim of regional policy should be to foster the rise of industrial clusters in geographical areas where market forces are failing. Thisse (2000), however, argues that instead of trying to organize such clusters from above, European regional policy-makers should aim at diversifying their technological infrastructure through enhanced scientific and engineering capabilities and improved institutional setting.

In the present paper we explicitly study how regional policy and economies of agglomeration have affected the location of multinational firms within the Republic of Ireland. Ireland provides us a with a rich institutional backdrop within which to analyze the issues at hand given that there has been interventionist regional industrial policy in Ireland for over 50 years, with some important changes over time. Ireland's industrial policy is probably best known for its ability to attract, through generous tax relief and grant assistance, high performance, hi-tech multinationals that have been the driving force behind its economic success since the early 1990s and have earned it its name the 'Celtic Tiger'; see Barry and Bradley (1997).[1] Importantly, however, Irish industrial policy makers have ensured that these interventionist tools contained a

[1] In a recent report, Braunerhjelm et al. (2000) also argued that Ireland's policy of public investment in skills and education, the reform of labor markets and the development of attractive tax and regulatory environment for foreign direct investment are crucial in explaining the recent Irish economic boom and that the absence of such policy measures may explain why other EU regions with comparable initial economic development have not enjoyed similar economic success.

strong regional component, at least for certain type of firms, in order to attempt to disperse incoming industrial activity to its less advantaged regions.

While the importance of multinational companies for the Irish economy has been analyzed in the recent literature (e.g., Barry and Bradley, 1997, Görg and Strobl, 2002) there does not appear to be any in-depth analysis of the location patterns of MNCs. In this paper we utilize exhaustive plant level data of manufacturing plants in Ireland between 1973 and 1998 in order to trace the location of all multinationals over the period and estimate the determinants of their location choice using a rich set of potentially important explanatory variables. To this end we employ the nested logit model described by McFadden (1978), which proves to be particularly appropriate given that we are able to analyze location decisions by grouping location alternatives into regions that were explicitly defined by policy. Also, by distinguishing set ups of plants in hi-tech and low-tech industries we attempt to examine whether the determinants of multinationals' location choices in general differ in the presence of potential knowledge-related externalities and differential regional policy.

The remainder of the paper is structured as follows. In section 2 we review the existing literature while in section 3 we describe the evolution of regional industrial policy in Ireland. Section 4 describes the data used. In section 5 we present the empirical model tested while section 6 presents our econometric results. Section 7 concludes.

2 Related literature

There are a number of papers, using discrete choice models that have analyzed whether public incentives have been effective in attracting new start-ups to particular locations. For example, the incentives created by tax exemption are examined by Carlton (1983) and Bartik (1985) for new firm location decisions in the US, and by Guimarães et al. (1998) for Brazil. These papers find only modest, if any, effects of tax or other regional incentives on firm location. Following the increasing importance of foreign direct investment worldwide much research has also been conducted into modeling the location decisions of multinational plants. Most research of this kind seems to have addressed the location decisions of foreign firms locating in the US, see, for example Coughlin et al. (1991), Coughlin and Segev (2000), Friedman et al. (1992), Woodward (1992) and Head et al. (1995, 1999).

While there is strong support for the idea that agglomeration economies are important for attracting new foreign plants, the evidence on the role of tax and other incentives is disputed. As mentioned above, despite the fact that most studies find that lower taxes and other incentives attract the location of multinationals, the economic significance of such incentives is considered to be small (e.g., Head et al, 1999). Devereux and Griffith (1998) and Crozet et al. (2002) are examples of such location studies for European countries. The former examine the choice of location for US firms locating in the European market and they find that both agglomeration of existing firms and the tax rate plays a role in the choice between alternative locations in Europe. Crozet et al. (2002) study the location of multinationals in France. They also find agglomeration economies to be important, while national or European regional policy incentives play a very small role.

Despite the growing number of empirical studies on the topic, the way public incentives and agglomeration economies are considered together arguably remains unsatisfactory. The latter are generally considered as the number of multinationals with the same nationality in a particular region as in Head et al. (1999) or Crozet et al. (2002) or by total sectoral employment in that area, as in Carlton (1983). In a recent study, however, Guimarães et al. (2000) follow more closely the urban economics literature by considering agglomeration economies represented by localization and agglomeration of service activities in a discrete choice modeling of FDI location in Portugal, although it must be noted that they do not study the role played by public incentives.

3 Public incentives and regional policy in the Republic of Ireland [2]

The regional dimension has been an important aspect of Irish industrial policy for more than 50 years, although it has undergone considerable changes. As a matter of fact, after 20 years of near autarky protecting Irish agriculture and a very small industrial base, the first step towards trade liberalization and promotion of manufacturing activity was primarily regional. An explicitly Irish industrial regional policy first came into existence through the "Underdeveloped Areas Act" of 1952, in which a number of underdeveloped, termed 'designated' areas were assisted by

[2] For a comprehensive review of Irish regional policy, see Meyler and Strobl (2000).

providing grants for machinery, equipment, land and buildings, in order to provide an alternative source of employment to replace declining agricultural employment in rural areas.[3]

In the late 1950s increasing concern with the overall national economic situation led to an erosion of the regional emphasis in favor of a more nationally oriented approach based on export-led growth, by also providing grants, although not to the same extent as for designated areas, to those areas deemed to be non-designated. By the late 1960s this approach was particularly geared towards trying to attract foreign multinationals into Ireland by not only offering generous grants but also export tax relief.

In response to a report by Buchanan and Partners (1969), which proposed the creation of a number of regional development centres in the less developed regions, and public debate advocating active policy in the 1960ies, there was a significant shift in regional industrial policy in the early 1970s with the adoption of the "Regional Industrial Plans for 1973-1977".[4] These plans focused on creating a large number of town clusters in the designated areas to ensure the maximum geographical dispersion of new industrial development, by the Irish governing body for industrial policy, the Industrial Development Authority (IDA).[5]

The approach adopted to achieve such was to set specific job creation targets for the chosen town clusters and the purchasing of industrial sites and building of advance factories in order to attract foreign firms to these areas. Moreover, at an organizational level, there was strong pressure on IDA personnel to fill those factories and industrial sites. As a matter of fact, the IDA often tried to influence the location of inward investment by deliberately bringing potential investors along predetermined "itinerary" routes (Breathnach, 1982). This 'target town' approach was continued in *"The Regional Plans for 1978 to 1982"*.

After 1982 there was a marked change in Irish industrial policy in that an explicit national strategic industry component, namely trying to attract hi-tech foreign multinationals to jump-start the virtually non-existent indigenous hi-tech sectors was given priority over regional dispersion. Although intention of the latter still was important, it was, in contrast to the earlier regional plans, of a much more *laissez-faire* nature in that the IDA tried to tempt firms to locate in designated

[3] The initial designated areas were Sligo, Leitrim, Roscommon, Mayo, Galway, Clare, Donegal, Kerry, and West Cork.

[4] A great deal of this discussion centred on growth pole policy, which rests on the central tenet that « growth does not appear everywhere and all at once » (Perroux, p. 143, 1964).

areas by offering higher grants instead of setting specific regional job targets for regions, purchasing industrial sites, and building advance factories and then making it a priority to fill these. In essence then, industrial policy maker's primary efforts were in trying to attract hi-tech foreign-owned industry into Ireland, while regional dispersion of multinationals became of secondary importance. This overall industrial approach has, more or less, remained until today.

Finally, one should note that the actual implementation of regional policy in Ireland, at least in its more modern history, has been of a more hands-on nature where potential multinationals bargained out with Industrial Development Authority officials what incentives they would get where, rather than following an explicit scheme of what actual level of grant was to be offered for each potential location.

4 Description of the data

The main data source used for the empirical study is the *Forfás Employment Survey*, an annual plant-level survey of all existing indigenous and foreign manufacturing firms in Ireland collected since 1972 by Forfás, the policy and advisory board for industrial development in Ireland. The response rate to the survey is estimated by Forfás to be generally well over 99 percent, i.e., our data can be seen as including virtually the whole population of manufacturing firms in Ireland. Information collected at the plant level is the level of employment, the sector of production, the nationality of ownership, and detailed location of the plant.[6] What makes this data set particularly attractive for our purpose is that it allows us to track the birth, employment level and location of essentially all plants that existed in Irish manufacturing since 1972.[7]

We also supplement our employment data set with information on wages at the regional/sectoral level from the *Irish Economy Expenditure Survey*. In contrast to the *Employment Survey*, this data source only surveys 60 to 80 per cent of all large manufacturing establishments. Moreover, it was initiated only from 1983 onwards and thus when we use information from this we are only able to analyze part of our total sample period. However, it

[5] The number of designated areas was increased for this purpose.
[6] 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.
[7] We interpret the start-up of a plant as the first time it has a positive employment level in our data set, unless it has positive employment in 1972. For these latter groups of plants we use information on the start-up year of the plant also provided in the dataset.

must be noted that this break also coincides with when regional policy experienced some important changes, and hence throughout our analysis serves as a natural temporal breakdown.

The geographical dimension used is the county-level, where Ireland officially has 26 counties, although for our purposes here we divide Ireland into 28 areas. The extra two regions, that is the breakdown of two counties into two further sub-areas, arises because Forfás itself divides North and South Tipperary into two areas for administrative purposes and the fact that only parts of Cork are considered to be 'designated areas' for policy purposes. The average area of a county is about 2600 km^2. Most importantly, these Irish regions correspond to meaningful economic areas and are usually defined around some urban cluster. This feature is arguably important given that the kind of agglomeration economies discussed before prove to be meaningful only if the local dimension of such economies is well represented. The designated areas over our sample period were Donegal, Sligo, Leitrim, Roscommon, Mayo, Galway, Kerry, Cavan, Monoghan, Longford, Clare, and West Cork.

Table 1 provides some descriptive statistics on the incidence of entry of foreign plants into Irish manufacturing industries between 1973 and 1998. Over the total period, 1,325 start-ups are recorded in the data. By far the most important home country for such foreign plants is the US, which accounted for almost one third of all entries, followed by Great Britain and Germany, respectively. It is worth pointing out the low number of Japanese plant locations in Ireland – over the total period Japan only accounted for 41 plant locations. One should compare this, for example, with 72 locations of Dutch plants and 30 locations of Swedish plants over the same period, or the importance of Japanese investment for the US (Head et al., 1995, 1999).[8]

[Table 1 here]

5 A nested logit model of multinationals' location choice

This section presents the empirical model of plant location estimated below. We assume that firms are profit maximizers and therefore choose the location which offers the highest expected profits. We write the restricted profit function of firm *i* in location *l* as

$$\pi_{il} = X_{il}\beta + \varepsilon_{il} \qquad (1)$$

[8] Also notable is the decline in the relative importance of Great Britain as a source of plant locations. While Great Britain was the most important source country in the early to mid 1970s it has since been overtaken by the US and, in

where profit π is composed of a systematic component, captured by a vector of location specific covariates X and a random component ε_{il}. This profit maximization problem is a variant of McFadden's (1974) random utility maximization model as shown by Carlton (1983). Assuming that the ε_{il} are independently distributed across i and l and that they follow a Weibull distribution, the model can thus be estimated using the conditional logit model as suggested by McFadden. This error structure implies the "Independence of Irrelevant Alternatives" (IIA) assumption, i.e., the choice between two alternatives is independent of changes in the choice set or of a third choice. The IIA property may be problematic in the case of location studies since it is reasonable to expect that there is correlation between similar alternatives.[9]

One way to control for violations of the IIA assumption is to use nested multinomial logit (NL) estimation, the approach we follow in this paper.[10] The NL approach allows dividing the choice set *a priori* into mutually exclusive subgroups, where IIA is assumed to hold within but not across subgroups. In other words, each subgroup contains choices with similar attributes. The distinctive feature of our empirical model is that at least parts of our subgroups correspond to the distinction made by Irish regional policy-makers. The structure of our empirical model is then fully justified for the sake of regional policy. The choice model can then be described by a tree structure where the decision maker first considers the choice between the subgroups and then makes a choice for one of the alternatives in the chosen subgroup (the lower nest).[11]

Denoting the upper level alternative as u and the lower level alternatives as l the probability of firm i locating in region l is $P_{ul} = P_{l|u} * P_u$, where

$$P_{l|u} = \exp(\beta Y_{ul}) \Big/ \sum_{n \in u} \exp(\beta Y_{un}) \qquad (2)$$

and

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some instances, Germany as well. This may be partly explained by the decline in reliance on Great Britain following Ireland's accession to the EU (then EC) in 1973 and the subsequent break in the Sterling – Punt fixed parity link.

[9] Carlton (1983) argues that the IIA assumption is not problematic if "possible locations […] are geographically quite distant so that common omitted variables among close locations should not be a problem" (p. 441). This may, however, not apply to our case of Ireland where possible locations are relatively close together. Following Hausman and McFadden (1984) we tested for IIA by comparing results of a conditional logit of the basic model on the full alternative set, and then exclude the alternatives of designated areas. If a subset of the choice set is truly irrelevant, omitting it from the model should not lead to significantly different results. However, the Hausman tests comparing the two models suggest that the results are different; we therefore conclude that IIA does not hold.

[10] See Maddala (1983) for a textbook discussion of conditional logit and nested logit estimation.

[11] It is important to note that even though such a tree structure suggests a sequential decision making process this does not imply that firms actually make decisions sequentially. It is just a way to analyze the decision process by grouping potential choices and take into account possible dependence among alternatives. (Goldberg, 1995).

$$P_u = \exp(\alpha Z_u + \sigma_u IV_u) \Big/ \sum_m \exp(\alpha Z_m + \sigma_m IV_m) \qquad (3)$$

Y and Z are the vectors of explanatory variables specific to the n lower level regions within the same upper nest, and the m upper level groups, respectively. IV is the "inclusive parameter" $IV_u = \ln(\sum_{n \in u} \exp(\beta Y_{un}))$. The coefficient on the inclusive parameter, σ, is of particular interest as it provides information on whether or not the model is properly specified. First, McFadden (1978) shows that the NL specification is only consistent with random utility maximization if the coefficient takes on values between 0 and 1. Second, if $\sigma = 1$ then the model collapses to the standard conditional logit model and the tree structure is superfluous (Maddala, 1983). Third, since σ can be thought of as a proxy for the correlation of choices within each subgroup (Guimarães et al., 1998), if $\sigma = 0$ then the subgroup choices are highly correlated and only the upper nest choice matters for the location decision.

In considering what grouping of location choices to use for the upper nest of the tree structure, we first experimented with simply categorizing areas into designated and non-designated status, as defined by policy. However, in all estimations in the spirit of what is outlined below the derived inclusive values indicated no support for such a structure.[12]

Given that Dublin, the capital, is by far the largest metropolitan area in Ireland (with between one fourth and one third of the population living in Ireland), implying huge differences in terms of population, services etc. relative the rest of the Republic, it seems intuitive that the choice between this region and the rest of the non-designated areas is not independent and thus should be included as a separate group within the upper nest of the decision tree. Moreover, Dublin's economic influence is likely to go beyond its regional (county) boundaries. For example, around 30% of firms over the period considered in this paper choose counties bordering on Dublin, presumably in order to avoid growing congestion costs in, but still avail of the benefits of locating near, Ireland's capital. In the upper nest we thus allowed for three groupings: (1) greater Dublin, i.e., Dublin including its surrounding counties Kildare, Meath and Wicklow, (2) the remaining Non-Designated Areas, and (3) all designated areas. This tree structure is shown in Figure 1.

[Figure 1]

[12] Detailed results are available from the authors.

The NL model is estimated using full-information maximum likelihood estimation. This estimation technique yields asymptotically efficient parameter estimates (Hensher, 1986). An alternative estimation technique is to use sequential estimation where equations (2) and (3) are estimated in a two step procedure (as used in the related papers by Hansen (1987), Guimarães et al. (1998) and Crozet et al. (2002)). This procedure also results in consistent parameter estimates, however, the estimates of the covariance matrix are neither efficient nor consistent (Hensher, 1986).[13]

[Table 2 here]

Table 2 describes the variables included in the vector of covariates X_{il} in equation (1). In the upper-nest we consider both benefit-related and cost-related variables influencing profit maximization. For the first group of variables we use the two traditional agglomeration variables as used in urban economics studies, see Glaeser et al. (1992) and Henderson et al. (1995). The variable *localization* represents the share of the same Nace 3 digit industry in total county-employment representing 84 industries with FDI in our data. If externalities are industry-specific, then firms may benefit from a high specialization at the county-industry level and the *localization* variable is expected to display a positive sign. The *urbanization* variable is represented by the Herfindhal index at the county-industry level: $\sum_l s_{l,k}^2$, where $s_{l,k}$ is share of k industry employment in total manufacturing employment of county l. The higher this index, the lower is the diversity of industries for a particular county and thus the lower are the expected gains from urban diversity in manufacturing activities. If economies from urban diversity arise, then the sign of this variable has to be negative. One should note that both *localization* and *urbanization* variables have been constructed using the whole dataset covering all manufacturing employment (both domestic and foreign) in Ireland.

Another important factor explaining the location of industries following the Marshallian view may be found in labor market pooling. Firms choose to locate in certain areas because they will be more likely to find the labor force with the specific skills they need. However, we do not have the appropriate information on labor skills at the county-level for Ireland. We then have to rely on an indirect measure of skills represented by the level of wage per head in the whole

[13] Amemiya (1978) develops a procedure to correct the covariance matrix to produce consistent estimates, which was used by Guimarães et al. (1998).

manufacturing industry. According to Becker (1964), the wage rate is a relevant measure for workers' skills if workers are able to capture any returns to human capital through higher wages. As noted earlier, we have information on this variable only for the period 1983-1998, and thus have to restrict our time span under consideration to this period when including the wage rate as a measure of labor skills.

As argued by Guimarães et al. (2000), there may be spillovers that are specific to multinationals, that is, multinationals may benefit from the presence of other foreign firms in the same area and/or industry. Previous authors including among others Head et al. (1995, 1999) and Crozet et al. (2002) used information based on the nationality of foreign investors in order to explain multinationals' location choice. For example, Japanese firms in the US tend to cluster in the same location given that their activities are closely linked through *keiretsu* affiliation. In addition Guimarães et al. (2000) also argue that there may be advantages for foreign firms (independently of their nationality) to locate where foreign presence is high if foreign presence reduces uncertainty. In order to consider these foreign-specific agglomeration economies we include in our regressions two additional variables represented by the number of firms with the same nationality in the same county (*nationality*) and the foreign share of total employment by county-industry (*foreign share*).[14]

On the cost side we include a *transport infrastructure* variable that measures the distance of each county's main city to the nearest international port and airport. This variable is important if multinationals export a large majority of their production realized in Ireland.[15] Distance here is measured in minutes spent by road to get from a county's capital to the nearest port or airport, as measured by the Irish industrial policy authority *Forfá*s in 1998.[16] If transport infrastructure is important for location decisions, then multinationals will locate close to existing international

[14] One could argue that these two variables are likely to be strongly correlated. We checked this by computing the correlation coefficient between those variables and it turned out that it was around 0.14 for the overall period, with little change across different time periods. We thus chose to include both variables in our estimations.

[15] For example, foreign firms exported 68% of their production on average in 1983 and 70% in 1998 while for domestic firms this percentage was only equal to 37% in 1983 and 39% in 1998. Source : Forfás and authors' computations.

[16] We took the average of distance in time from international port and airport according to the definition give in table 2. Unfortunately, a consistent time series on this variable is not officially available for Ireland. This is a clear limitation in our data since we do not know whether possible changes have influenced transport infrastructure as it is likely to have been the case of the last 30 years. However, Irish public investment in transport infrastructure has been only modest until recently compared to other EU peripheral countries so one can expect those figures to be roughly representative of differences in transport infrastructures across counties, especially from the mid-1980s onward.

transport infrastructure and the expected sign for the *transport infrastructure* variable is thus negative.

In addition, despite the fact that agglomeration economies have been largely proven to arise in urban and regional economies, one may also consider that agglomeration may entail diseconomies, for example through pollution or higher land rents. Specifically, land and housing prices in Ireland display major differences across the country and notably between Dublin and the rest of the Republic, see Roche (2001). Since we do not have information on industrial land prices we have used population density instead, following a number of authors including Bartik (1985) and Guimarães et al. (2000). We expect this variable to display a negative sign if such diseconomies arise. One could also argue that the population density may in fact capture demand-side agglomeration economies, that is, firms locating near their potential markets. However, given that, as argued before, the relevant market for multinationals located in Ireland is not the local market, the possibility that population density may capture market-size effects appears to be remote.

One should finally note that all explanatory variables are considered at time *t-1* for the location choice made at time *t* in order to avoid simultaneity problems.

The dependent variable in the NL estimation is the location choice of each foreign investor. Recall that for each location we have 28 possible location choices. The dependent variable is equal to 1 for the county where plants are located and 0 for all other 27 alternatives. The explanatory variables are also calculated for all 28 possible location choices. Table 3 provides the mean values of the explanatory variables.

[Table 3 here]

Some interesting features arise that we will use later when analyzing our econometric results. First, despite the fact that the real wage rate has increased over the overall period, the standard deviation has slightly risen. In particular, while the annual wage rate in Dublin was noticeably higher in 1983 than in the rest of Ireland, some surrounding counties like Kildare and Wicklow have reached levels close to Dublin's average wage level. If wages are a good approximation of skills then one may argue that these counties have been catching up with Dublin and consequently improved their attractiveness for skill intensive industries.

In terms of localization, county Kildare has, by far, reached the highest value in 1998 while Dublin is in an intermediate situation. However, the high value of the localization index

may have only a small influence on the value of this variable for Dublin's region given that county Kildare only represented 8% of total employment and 12% of the number of plants location in this region. More interestingly, Dublin has the highest degree of urbanization both at the beginning and at the end of the period. Accordingly, if agglomeration economies related to technological spillovers and knowledge-based externalities are more likely to arise when diversity is high, as argued by Jacob (1969), or when labor is highly skilled, then one may expect that hi-tech activities will locate preferably in Dublin or its surrounding regions. This is partly confirmed by the values of the foreign employment share and also by results in Table 4 showing that greenfield investment in hi-tech industries was dominant in the greater Dublin area (including Dublin l and its surrounding counties), especially from the mid-1980s, that is, when FDI in Ireland was predominantly of these kinds of industries.

[Table 4 here]

One should also note that the average values for the number of foreign firms by nationality display huge differences, mostly between Dublin and the rest of Ireland. This is essentially because FDI in Dublin was mainly by US firms in hi-tech industries over the period, as also shown in Table 5. More generally, plant openings became dominant in hi-tech industries from the 1980s onwards. [17]

[Table 5 here]

Table 5 and Figure 2 also show that while a majority of new plants in such industries opened in non-designated and especially in Greater Dublin's area, a non-negligible number of plants also started-up in designated counties. Despite this, foreign firms investing in Dublin's region are by majority hi-tech firms which is not true for designated areas, especially from the mid-1980s onward. A similar, albeit less pronounced, pattern arises for the other non-designated areas excluding Dublin and its surrounding regions.

[Figure 2 here]

6 Econometric results

For the estimation of the location choice model we first consider the full time period 1973-98 pooling all sectors. Furthermore, we consider four different sub-samples. Given the

[17] The breakdown between hi-tech and low-tech industries is taken from Görg and Srobl (2002) and is included in the annex.

distinct policy break in 1983, we felt it was important to explicitly distinguish between multinational location before and after this break. This also coincides with the period in which we have additional information from the *Irish Economy Expenditure* database. Also, because of the focus of industrial policy in the latter period on the attraction of hi-tech firms in general, we further split our two period samples into those referring to the location of hi-tech, and those that correspond to low-tech firms.

There are also other reasons for separating our sample by the technology intensity of sectors. For example, for hi-tech industries the skill level of workers is generally more important than for low-tech industries. Economic geographers also put much emphasis on the fact that innovative activities tend to locate in urban areas where knowledge-related spillovers are particularly intense. For example, Duranton and Puga (2001) show how such activities first locate in cities at their initial stage of development and then relocate to low-urbanization areas in order to benefit from economies of scale and lower production costs when production expands. In addition, Beardsell and Henderson (1999) show that urban diversity plays an important role in attracting or keeping hi-tech firms. Thus constraining the estimated parameters to be the same across hi-tech and low-tech sectors may be a very stringent assumption. In all our specifications, a simple likelihood ratio test where we compared the model where coefficients are assumed to be same across the two sector groups with one where these are allowed to vary by using interaction terms, clearly supported the break-up of our sample by sector group.[18]

General results without distinguishing between hi and low-tech sectors are presented in Table 6. Overall the results provide support for our nested logit model structure since the likelihood ratio test generally shows that we can reject the hypothesis that the inclusive values are jointly equal to 1. The LR test for the model concerning the 1973-82 period shows that a conditional logit should be preferred to the nested logit approach. However, non-reported regressions showed results qualitatively similar to those reported here. The inclusive value parameters are also significantly different from zero meaning that multinationals are not indifferent in their location choice between counties within groups of regions.

[Table 6 here]

For the overall period, upper nest level estimated parameters show that the disadvantaged status does not provide counties with an advantage in attracting foreign investors for the whole

period. However, the breakdown of the sample across periods provides evidence that there are some differences across time. During the 1983 to 1998 period, designated areas seem to have benefited from their status in attracting foreign firms, as shown by results in column (3). As noted in section 3, this period also corresponds to a more liberal approach of regional policy. Using the estimated coefficient for the designated area in this column and considering that there is an average probability of 12/28 for a designated area to be chosen by a multinational since there are 12 counties within this category, the estimated probability of choosing a designated area is then 0.247* (1-12/28) = 0.14. In other words, higher public incentives in designated areas have increased by 14% the probability that a typical multinational choose this kind of county to set up a plant.

Our results also show that Dublin's region has been somewhat disadvantaged in terms of attracting FDI compared to other counties, especially during the earlier period. Multinationals have thus tended to disperse across Ireland during the whole period. This may be due to increased congestion costs in Dublin's area. However, the weak result of our *population density* variable does not seem to capture this effect limiting any definitive conclusion on this ground.

The two agglomeration variables, *localization* and *urbanization*, generally display the expected signs and are important determinants of multinationals' location choices. The *localization* variable displays similar coefficients in absolute terms in the sub-periods as for the whole period. In turn, the *urbanization* variable also displays the expected sign but it is only significant for the whole as well as for the 1983-1998 period suggesting important changes in the determinants of multinationals' location choice in Irish regions. In particular, one should note that during the whole period 21 out of the 101 NACE 3 digit sectors were new sectors in Ireland, such as electronic components, hi-tech machinery, and precision instruments. In addition some hi-tech sectors like computers or electrical engineering have risen dramatically over the period modifying substantially the nature of Irish industrial specialization (see Görg and Ruane, 2001).

Beside *urbanization* and *localization* economies our results also indicate that *foreign-specific* agglomeration forces have been important determinants of the geographical distribution of FDI in Ireland over the whole period, with both proxies being always positive and statistically significant at the 1% level. Results concerning the transport infrastructure show that distance

[18] Similar results were found when trying to restrict coefficients to be the same across time periods. Detailed results

from major port and airport has a significant negative effect on firm location for the overall sample and for both sub-periods. In turn, our population density variable does not seem to capture the congestion problem appropriately since it is never significant. In the absence of data on industrial land price it is hazardous to draw definitive conclusions on this ground.

Results for our four sub-samples are described in Table 7, namely low tech firms that located over 1973-1982, low-tech firms that located over 1983-1998, hi-tech firms that located over 1973-1982, and hi-tech firms that located over 1983-1998. Here again, the results generally provide support for the nested logit model structure adopted in this paper since the likelihood ratio test generally shows that we can reject the hypothesis that the inclusive value is equal to 1. The only sample for which this is not the case is the 1973-82 period for low-tech firms, thus suggesting that running a conditional logit specification would suffice. However, a conditional logit specification produced similar results, and we thus, for comparability reasons, only report the nested logit results here.[19]

[Table 7 here]

According to our results, regional policy has only been effective in attracting low-tech multinationals during the latter period to the designated areas (relative to non-designated areas). Here we find that higher public incentives in designated areas have increased by 24% the probability that a typical multinational chooses a designated region to set up a plant. For hi-tech multinationals we find no such effect, but the significant negative coefficient on the Dublin dummy suggests that, relative to other non-designated regions, hi-tech multinationals were less likely to locate in the greater Dublin area in the latter period. One would suspect that this is due to the rise in congestion costs in this area during that period.

Some interesting results appear concerning our two agglomeration variables. First, the urbanization variable appears to be larger for hi-tech industries. In order to verify this we ran an LR test of the regression on the full sample including an interaction term of the hi-tech dummy with all explanatory variables versus a model excluding such interactions for the urbanization variable. The null hypothesis of no significant differences between the high and low-tech firms urbanization variable was rejected at the 10% level. In addition we ran a simple t-test of

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are available from the authors.

[19] Detailed results are available from the authors.

differences in coefficient and the urbanization variable turned out to be significantly higher for hi-tech firms at the 5% level.[20]

If one considers that hi-tech industries are more likely to locate in highly urbanized areas and/or close to labor markets where skilled labor is relatively abundant then designated areas should suffer from a clear disadvantage compared to the other regions. This was apparent from the descriptive statistics provided in Table 3. Here again, substantial changes in the composition of Irish industry and the emergence of hi-tech sectors seem to explain why the urbanization variable is only significant for the later period. More importantly, our result is in line with Henderson et al. (1995) who have shown that urban diversity is more important for hi-tech industries, although the previous authors are more interested in the influence of these externalities on regional employment growth.

In addition, we find that the localization variable is only significant for low-tech firms. The *MAR*-kind of externalities discussed above seem thus to explain only the location decision of low-tech multinationals, that is, only those regions specialized in low-tech activities like textiles, basic metals or food product seem to attract foreign investors in similar activities. This result is also in line with Henderson et al. (1995) who found that M*AR* externalities explain why some traditional industries stay put in highly specialized regions. Our results thus indicate that counties with a historical tradition in some particular industries offer a better environment for potential foreign investors.

Until now we have not included our proxy for the local skill level as a determinant of foreign plants location choice. This can be a problem since our urbanization variable could very well capture the influence of labor market pooling forces through which multinationals locate in densely urbanized areas in order to find qualified workers. In order to check this in Table 8 we report results including the level of wages per head in total manufacturing.

[Table 8 here]

Given that data on wages were only available from 1983 onward, we restricted the time span of our analysis to the 1983-98 period. The wage variable displays a significant and positive coefficient and seems to capture part, but not all, the influence of the agglomeration and the foreign-specific variables. Moreover, it is helpful to go back to the descriptive statistics provided

[20] Results of those tests are available from the authors upon request.

in Table 3 showing that counties surrounding Dublin have experienced a dramatic rise in their average wage level compared to the rest of Ireland. According to our assumption, the improvement of regions surrounding Dublin in terms of labor force skills has provided these counties with a distinctive advantage with respect to other areas of Ireland.[21]

7. Summary and conclusions

This paper provides, to the best of our knowledge for the first time, a detailed analysis of the location decisions of multinational firms in Ireland. We use a nested logit estimation technique and an exhaustive plant level dataset for the manufacturing industry covering the period 1973 to 1998. Our particular interest is on investigating the importance of regional policy measures in an empirical model where agglomeration economies are also considered.

From our empirical analysis we find that regional policy has been an effective tool in promoting the location of foreign plants in disadvantaged counties, but only for low-tech firms since the mid-1980s when a much more *laissez-faire* approach to regional policy was introduced and policy makers were less (relatively to the earlier period) intent on dispersing hi-tech firms. A closer look at the role played by agglomeration economies as determinants of firms' location shows that urbanization economies have been important for the location decision of hi-tech multinationals since the mid 1980s while localization economies had no effect. This result corresponds to the view that high-value added and innovative industries first locate in urban centers in order to avail of knowledge-related spillovers from the diversity of industries. In contrast, the location of low-tech firms seems to be only influenced by agglomeration economies created by *Marshall-Arrow-Romer* type of externalities.

[21] A likelihood ratio test similar to the one used for the urbanization variable did not indicate the size of the coefficient was significantly different across hi and low-tech sectors.

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Tables and graphs

Table 1: Number of plant locations

		By nationality						By county status		
year	Total	US	Japan	Great Britain	Germany	other EU	other non-EU	designated	non-designated*	Greater Dublin+
1973	63	18	0	21	9	9	6	32	21	10
1974	82	25	1	24	22	7	3	39	33	10
1975	46	15	2	12	7	8	2	19	17	10
1976	60	15	1	23	6	11	4	21	27	12
1977	59	21	2	9	3	19	5	16	28	15
1978	72	27	3	14	9	13	6	23	29	20
1979	53	23	2	9	8	7	4	14	19	20
1980	86	30	3	14	14	21	4	34	26	26
1981	82	39	1	5	15	12	10	25	43	14
1982	40	15	1	9	3	7	5	12	14	14
1983	51	23	1	4	7	11	5	24	17	10
1984	73	18	1	16	14	18	6	43	15	15
1985	61	20	0	17	12	8	4	17	26	18
1986	52	16	0	10	9	14	3	20	20	12
1987	42	7	2	14	8	7	4	16	11	15
1988	45	9	2	7	13	10	4	12	14	19
1989	36	9	3	10	7	3	4	18	12	6
1990	37	13	2	3	8	8	3	21	10	6
1991	39	15	1	7	5	8	3	15	13	11
1992	45	20	3	7	3	8	4	16	17	12
1993	29	13	1	6	4	3	2	11	6	12
1994	44	27	2	6	5	3	1	21	11	12
1995	30	14	1	5	4	3	3	11	9	10
1996	27	10	4	2	1	9	1	11	10	6
1997	35	26	2	0	3	1	3	11	15	9
1998	36	19	0	2	5	8	2	12	16	8
Total	1325	487	41	256	204	236	101	514	479	332

* Excludes Dublin's area regions

+ Includes Dublin, Kildare, Meath and Wicklow

Table 2: List of explanatory variables

Variable name	Description	Source
Localization	sector share of total employment in the county – NACE 3 digit sectors	ES[†], Forfás
Urbanization	sum of square sectoral employment share in the county – NACE 3 digit sectors	ES
Transport infrastructure	average of distance from each country's main city (in minutes by road) to the nearest international airport and port. An international port offers load-on load-off, roll-on roll-off and dry and liquid bulk handling capabilities	www.forfas.ie
Population density	county's total population / non-agricultural land in sq. meters	CSO[#], Dublin
Foreign share	foreign employment / total employment in county-sector (NACE 2 digit)	ES
Firms of own nationality	total number of foreign firms in county-sector (NACE 2 digit) with the same nationality	ES
Wage per head	Real wage rate for the manufacturing industry by county (deflator = CPI index)	IEE, Forfás
Disadvantaged status	dummy = 1 for designated areas	Forfás

[†] Employment Survey

[#] Central Statistical Office

***** see annex

Table 3: Mean values of the explanatory variables by area

	Wages per head		Localization		Urbanization		# foreign firms by nationality		Density population		Foreign share		Transp.infras.
	1983	1998	1973	1998	1973	1998	1973	1998	1973	1998	1973	1998	1973-98
Dublin	17.2	25.2	0.024	0.045	0.053	0.046	66.9	143.8	205.7	259.2	0.34	0.59	0.0
Kildare	11.7	24.2	0.029	0.161	0.084	0.242	3.8	6.8	16.1	29.9	0.17	0.68	50.0
Meath	12.4	17.3	0.027	0.012	0.103	0.060	1.7	2.9	17.02	25.7	0.21	0.23	40.0
Wicklow	11.5	20.5	0.016	0.056	0.084	0.065	1.0	6.2	7.3	11.2	0.09	0.65	60.0
Oth non-des	13.4	18.0	0.020	0.034	0.092	0.073	2.2	7.5	18.3	21.3	0.10	0.39	75.4
Des. area	13.0	16.7	0.022	0.031	0.096	0.0896	2.5	6.7	7.2	7.7	0.14	0.45	78.0

Table 4: Number of plant locations by regions' status and sectors' characteristics

	1973-1982		1983-1998	
Regions' status	Low-tech	Hi-tech	Low-tech	Hi-tech
Designated area	141	94	154	125
Non-designated area*	137	120	105	117
Dublin's region +	63	88	57	124
Total	341	302	316	366

* Excludes Dublin's area regions
+ Includes Dublin, Kildare, Meath and Wicklow

Table 5: Number of plant locations by nationality and sectors' characteristics

	1973-1982		1983-1998	
Nationality	Low-tech	Hi-tech	Low-tech	Hi-tech
United States	94	134	85	174
Japan	3	13	6	19
Great Britain	95	45	68	48
Germany	50	46	65	43
Other EU	72	42	67	55
Other non-EU	27	22	25	27
Total	341	302	316	366

Table 6: Base-specification, nested logit

	(1)	(2)	(3)
Period:	**1973-98**	**1973-82**	**1983-98**
	Lower Nest		
Localization	4.019**	3.769**	4.160**
	(0.806)	(1.183)	(1.150)
Urbanization	-5.392**	-0.236	-9.917**
	(1.359)	(1.906)	(2.032)
Transp. Infrastr.	-0.110**	-0.157**	-0.073**
	(0.19)	(0.028)	(0.028)
Population density	0.024	0.109	-0.028
	(0.047)	(0.069)	(0.068)
Foreign share	0.821**	0.657**	1.001**
	(0.098)	(0.134)	(0.147)
Nationality	0.017**	0.014**	0.019**
	(0.002)	(0.004)	(0.002)
	Upper Nest		
Designated	0.079	-0.094	0.247**
	(0.064)	(0.095)	(0.091)
Dublin	-0.321**	-0.431**	-0.174
	(0.079)	(0.159)	(0.106)
IV parameter	0.28**	0.460	0.217*
	(0.087)	(0.256)	(0.106)
LR (IV = 1)	23.0**	1.41	19.7**
Log likelihood	-4044.1	-1995	-2032.4
Observations	37100	18004	19096
# start-ups	1325	643	682

Standard errors in parentheses
* significant at 5%; ** significant at 1%

Table 7: Distinction between hi and low-tech firms, nested logit

	(1)	(2)	(3)	(4)
Sample:	**Hi-tech**	**Hi-tech**	**Low Tech**	**Low Tech**
Period:	**1973-82**	**1983-98**	**1973-82**	**1983-98**
		Lower Nest		
Localization	2.962	2.871	5.047**	5.095**
	(2.076)	(1.737)	(1.164)	(1.597)
Urbanization	-2.65	-13.886**	0.750	-7.360**
	(3.04)	(0.038)	(2.394)	(2.719)
Transp. Infrastr.	-0.160**	-0.130	-0.136**	-0.012
	(0.041)	(0.038)	(0.037)	(0.044)
Population density	0.0471	-0.099	0.194	0.032
	(0.094)	(0.091)	(0.110)	(0.103)
Foreign share	0.601**	0.938**	0.370	1.083**
	(0.183)	(0.196)	(0.239)	(0.230)
Nationality	0.027**	0.018**	0.005	0.020**
	(0.007)	(0.003)	(0.003)	(0.004)
		Upper Nest		
Designated	-0.247	0.068	0.149	0.424**
	(0.139)	(0.128)	(0.294)	(0.135)
Dublin	-0.342*	0.058	0.204	-0.476
	(0.149)	(0.129)	(0.887)	(0.207)
IV parameter	0.209	0.028	1.856	0.367
	(0.119)	(0.124)	(1.378)	(0.223)
LR (IV = 1)	7.38**	19.19**	0.46	4.04*
Log likelihood	-895.1	-1031.2	-1087.3	-983.7
Observations	8456	10248	9548	8848
# start-ups	302	366	341	316

Standard errors in parentheses
* significant at 5%; ** significant at 1%

Table 8: Nested logit results: effect of sector-characteristics, controlling for wage level – 1983-98

	(2)	(3)
Sample:	**Hi-tech**	**Low-tech**
Period:	**1983-98**	**1983-98**
	Lower Nest	
Localization	2.211	5.817**
	(1.726)	(1.587)
Urbanization	-10.145**	-4.871
	(3.093)	(2.747)
Transp. Infrastr.	-0.077*	0.014
	(0.040)	(0.045)
Population density	-0.172*	-0.041
	(0.093)	(0.107)
Foreign share	0.836**	0.956**
	(0.199)	(0.233)
Nationality	0.013**	0.016**
	(0.003)	(0.004)
Wages	0.129**	0.082**
	(0.030)	(0.028)
	Upper Nest	
Designated	0.067	0.434**
	(0.131)	(0.140)
Dublin	0.060	-0.347
	(0.135)	(0.264)
IV parameter	0.007	0.463
	(0.144)	(0.270)
LR (IV = 1)	18.56**	2.35
Log likelihood	-1022.0	-979.7
Observations	10248	8848
# start-ups	366	316

Standard errors in parentheses
** significant at 1%; * significant at 5%;

Figure 1: Tree structure for nested logit model

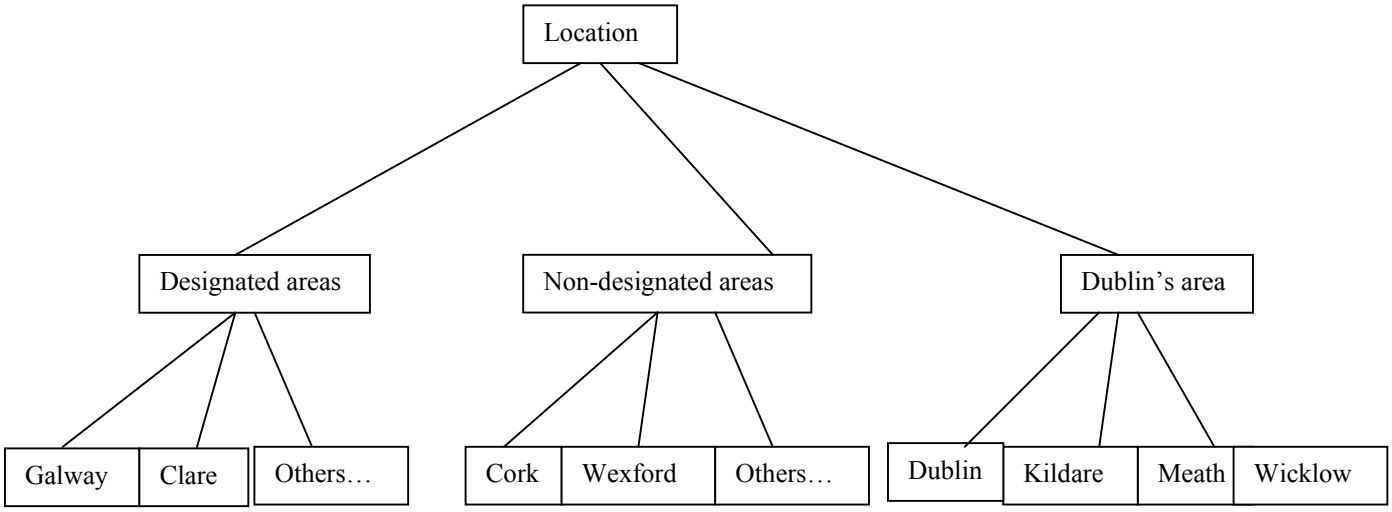
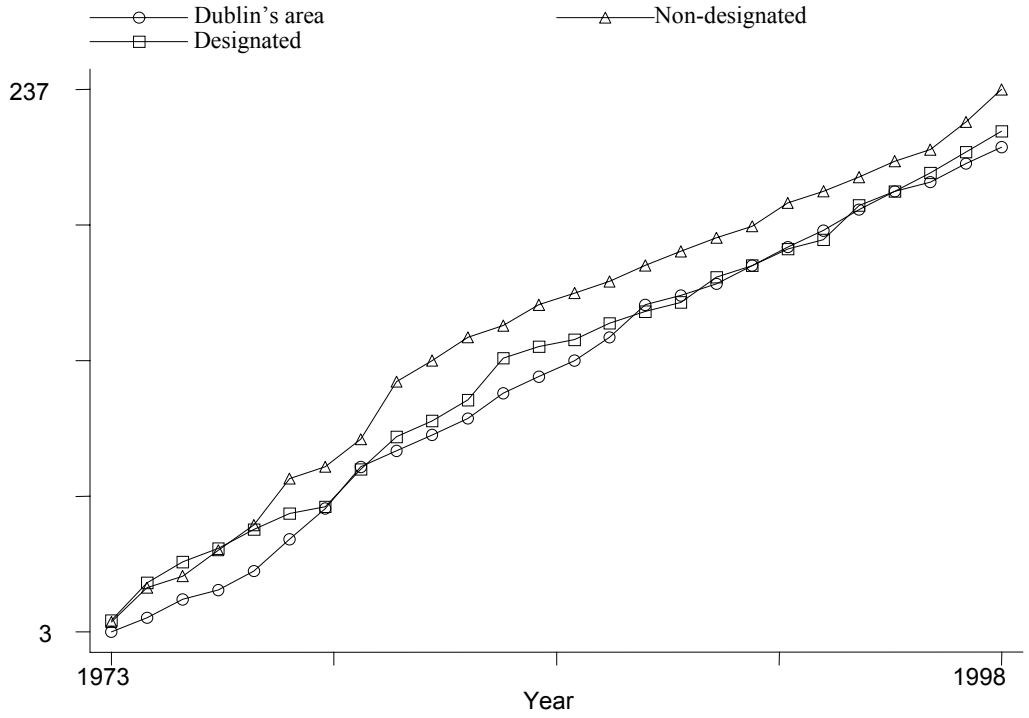
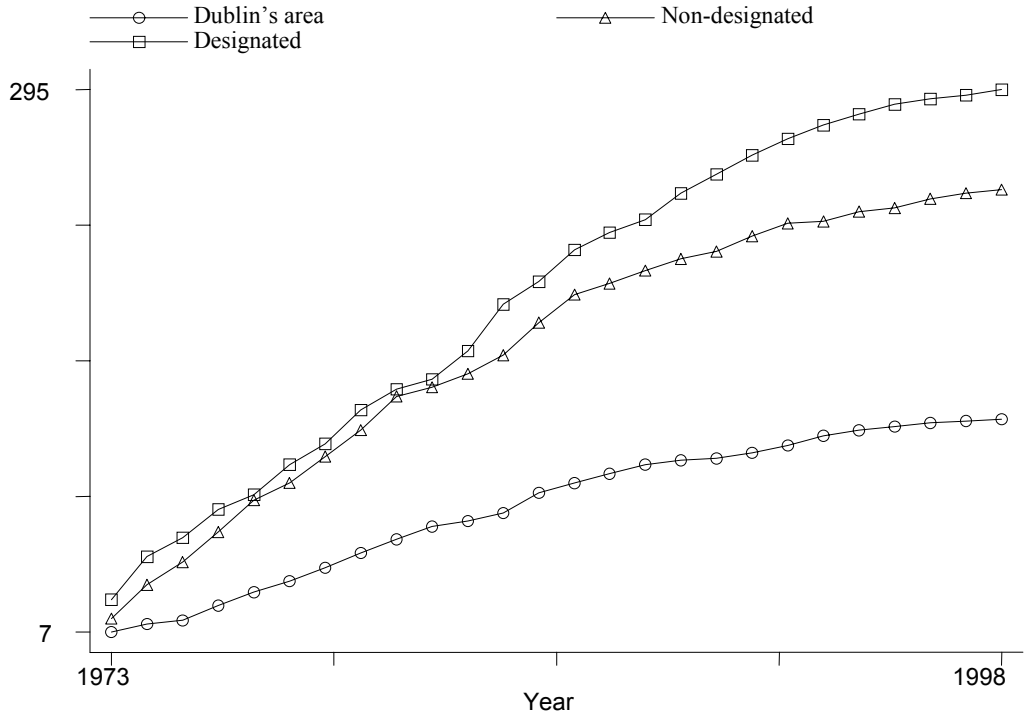


Figure 2: Cumulative entry of foreign multinationals in hi and low-tech sectors



Hi-tech



Low-tech

Appendix: Hi-tech Sectors

1. Basic chemicals
2. Pesticides and other agro-chemical products
3. Paints varnishes and similar coatings printing ink and mastics
4. Pharmaceuticals medicinal chemicals and botanical products
5. Soap and detergents cleaning and polishing preparations perfumes and toilet preparations
6. Other chemical products
7. Rubber and plastic products
8. Plastic products
9. Machinery for the production and use of mechanical power except aircraft vehicle and cycle engines
10. Office machinery and computers
11. Electric motors generators and transformers
12. Electricity distribution and control apparatus
13. Insulated wire and cable
14. Accumulators primary cells and primary batteries
15. Lighting equipment and electric lamps
16. Electrical equipment n.e.c.
17. Electronic valves and tubes and other electronic components
18. Television and radio transmitters and apparatus for line telephony and line telegraphy
19. Television and radio receivers sound or video recording or reproducing apparatus and associated goods
20. Medical and surgical equipment and orthopaedic appliances
21. Instruments and appliances for measuring checking testing navigating and other purposes except indust
22. Industrial process control equipment
23. Optical instruments and photographic equipment
24. Watches and clocks
25. Motor vehicles
26. Aircraft and spacecraft

Source: Görg and Strobl (2002)