TITLE:

FOREIGN DIRECT INVESTMENT IN MANUFACTURING. DO AGGLOMERATION ECONOMIES MATTER?

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INTRODUCTION

In the literature on the determinants of multinational activity, Dunning's "Eclectic Paradigm" provides perhaps the best overall approach. Eclectic theory suggests that an enterprise's FDI is determined by three types of potential advantage: ownership-location-internalization (OLI) advantages (Dunning, 1981). In other words, FDI is determined, first, by the extent to which the enterprise possesses net ownership advantages (Hymer, 1960; Kidleberger, 1969; Caves, 1971); second, the extent to which it is able to internalize these advantages or, on the contrary, must leave them for other enterprises to exploit (Buckley & Casson, 1976); and, third, the profitability of locating its production units either at home or abroad (Vernon, 1966).

But while FDI theory discusses why firms invest abroad, it has little to say about how or why a particular location within the host nation is chosen. The factors determining a firm's location comprise all the characteristics of its home territory that give the firm comparative advantages, including factor endowments (capital and labor) and natural resources. A further group of characteristics includes the role of external economies, i.e. increasing returns external to the firm but internal to the territory, in the location of economic activity.

Agglomeration economies are considered a key issue in foreign direct investment (FDI) and the literature has tended to focus on agglomeration effects as determinants of industrial location (Marshall, 1920; Hoover, 1936; Arrow, 1962; Romer, 1986; Jacobs, 1969; Krugman, 1991b; Audretsch, 1998; Fujita et al; 1999 are good examples).

Indeed, a number of studies have revealed the tendency of foreign investment to agglomerate. These include Bartik, 1985; Coughlin et al; 1991; Woodward, 1992; Shaver, 1998; Head et al; 1999; Guimaraes et al; 2000; Driffield and Munday, 2000, among others; However, little is known about the relative importance of agglomeration factors in attracting foreign direct investment. Are all industries attracted by the same agglomeration effects? Or do the affects of agglomeration economies vary with the specific traits of an industrial sector? To date, very few studies have attempted to analyse the

relation between foreign location and specific industrial characteristics (Luger and Shetty, 1985; Smith and Florida, 1994; Kuemmerle, 1999; Chung and Alcácer, 2002).

The main aim of this paper is to explore the role that agglomeration economies play as location determinants of FDI in manufacturing, with a particular emphasis on inter-industry heterogeneity. To do so, it is first necessary to identify the traits of those industries in which FDI has a higher propensity to agglomerate (in terms of capital intensity, labour intensity, R&D intensity, linkages and market orientation) and the relationship between these industry-specific features and regional characteristics, particularly those that tend to form agglomeration economies (manufacturing activity, same industry activity, concentration of services and regional R&D activities). In short, the paper examines the way in which inter-industry differences affect agglomeration economies and the location of FDI.

Clearly, an understanding of these questions is critical for firms and for regional policy makers. For new entrants, having information about the main determinants of location in a specific industry is crucial in making their strategic decisions. For policy makers concerned with the promotion of foreign direct investment in specific industries, information about the location characteristics that attract these firms is particularly valuable in strengthening existing location traits.

This paper assumes that firms maximize their utility, which is dependent on a range of regional characteristics including technical activity, market size, endowment factors and agglomeration economies, among others. The value attached to each of these attributes of location is a particular function of the traits of each individual firm.

With the aim of verifying whether agglomeration economies - in the same way as other socio-economic factors of location - have a significant effect on FDI, an econometric model is implemented across the different sectors of the Spanish economy. Given the fact that we have access to panel data, as well as cross-sectional information for different geographical areas and temporal information for the period 1992-2000, the methodology adopted for the model estimation is that specifically designed for panel data (Baltagi, 2001).

Our empirical results show that intra-industry traits affect the location of FDI. Of the various regional characteristics, agglomeration economies seem to be main factors of attraction, especially in industries with high level of linkages and in R&D intensive industries.

The paper is divided into four sections. The next section examines the theoretical approach and the main hypothesis to test. The second section describes the econometric model. The third section

presents the econometric methodology and reports the estimation results. The final section offers a summary and draws conclusions.

AGGLOMERATION ECONOMIES AND INDUSTRY TRAITS

Marshall's contribution at the end of the XIX century was pioneering. He identified three types of external economies that generate agglomeration (geographical concentration): specialized labor, specific inputs and technological spillovers. Hoover (1936) identified two major types of agglomeration economies: first, location economies, or externalities derived from industry-specific location, and, second, urbanization economies, in which the economies are external to the industry, but internal to the territory, and so benefit all the firms in the area.

The approach typified in new economic geography is centered on Marshall's ideas of firms' linkages, but it draws also on other common elements such as increasing returns, transport cost and factor mobility. As these elements interact, industry will either agglomerate or become dispersed in space depending on whether the resulting forces are centripetal or centrifugal respectively. Fujita, Krugman and Venables (1999) identify the main centripetal forces leading to spatial agglomeration as: 1) linkages: forward linkages and backward linkages, 2) the existence of thick markets and, 3) knowledge spillovers. Similarly, they identify the main centrifugal forces as: 1) immobile factors and, 2) congestion diseconomies.

Other studies have focused their attention on industrial clusters where firms can benefit from locating close to each other because of knowledge spillovers. The emergence of intellectual capital as a key strategic asset in the wealth creation process is one of the most significant changes over the last two decades. Dunning (1998) claims that a recent, significant change in the reasons underlying FDI is the growth in strategic asset-seeking FDI[1], aimed at protecting or increasing the ownership advantage of the investing firm, rather than at exploiting this advantage as is the case of traditional FDI. Thus, the location preferences of firms have shifted from traditional requirements, such as access to markets and natural resources to the need to have access to knowledge-intensive assets, confined mainly to developed countries, and which are characterized by a greater geographical concentration than other kinds of activity, (Kuemmerle (1999), Chung and Alcácer (2002)).

Location and specialization patterns are determined by the interactions between industry and a region's characteristics. The factor abundance of regions differs: some are relatively abundant in physical capital, some in human capital, while others are core locations offering easy access to many markets. Industries also differ in their factor intensity, technology level, intra-industry and inter-industry

linkages, and final demand orientation, among other factors. All these regional characteristics and industry traits interact to determine the pattern of location.

Here, our main assumption is that the role played by agglomeration economies as location determinants will depend on the specific traits of the firms. Industries that are particularly intensive in any one given factor will be attracted to regions that offer a relative abundance of that factor. To implement this hypothesis, the theory will tell us which country characteristics tend to be related with which industry traits.

This paper considers the following hypotheses. First, new economic geography has described the way in which forward and backward linkages - the centripetal forces - can generate a process of agglomeration whereby producers wish to locate near their suppliers and customers wish to minimize their transport costs. Thus, industries with high levels of intra-industry and/or inter-industry linkages will tend to locate near other producers in order to buy intermediate goods, and to sell their products. In this case, the positively valued attributes of a region are the existence of location economies and manufacturing agglomeration.

Second, firms seeking knowledge in order to augment their knowledge base will value locations that offer more technical activity, that is, regions in which there are more scientists, engineers, more patents, and greater R&D intensity. The firms most likely to value these regional characteristics positively will be firms in R&D intensive industries, where technical progress is critical. However, firms may also seek knowledge so that they can adapt existing products to provide greater satisfaction of local needs (Kuemmerle, 1999). In such a case, it is probable that these firms will attach most value to market opportunities.

Third, industries that are highly labour intensive, with low levels of demand and technology (according to the European Union Commission and OECD industry classification) will probably will not be interested in agglomeration economies or the size of the region's knowledge base; rather such firms will seek low factor costs. In this third case, it would be interesting to compare which variables have the greater capacity to attract: cost factors or agglomeration economies.

MODEL AND VARIABLES

Studies of the variables influencing the location decisions of manufacturing foreign investment have been hindered by the failure to develop, to date, a structural model of FDI determinants that can identify which of these factors might be considered pivotal and should therefore be included in any

further analysis. Researchers have had to rely on empirical studies that offer only certain insights into the variables and the way that they behave and interact.

Empirical studies of multinational locational choices at the regional level have mainly examined entry into U.S. markets (Luger & Shetty, 1985; Coughlin et al., 1991; Woodward, 1992; Friedman, 1992 and 1996; Head et al., 1995 and 1999). Following Carlton (1983) and Bartik's (1985) approach to branch plant location, most of these studies use discrete choice models to analyze new-investment decisions.

Similarly, a number of studies have examined the locational determinants of FDI within Europe. Scaperlanda and Balough (1983) analyzed the locational determinants of US investment in the EEC; Culem (1988) studied bilateral FDI flows between the USA and five European countries; Yamawaki (1991) and Thiran and Yamawaki (1995) focused on Japanese FDI in European countries and regions. Hill and Munday (1991 & 1992) sought to identify FDI determinants in the United Kingdom, as did Mariotti & Pricitello (1995) in Italy, Guimaraes et al. (2000) in Portugal, Egea & López Pueyo (1991b), and Pelegrín (2002) in Spain. With the exception of Guimaraes et al. (2000), who adopted a discrete choice model approach for new plant investment, the other studies employed a multiple regression or panel data approach, using all forms of FDI, not just greenfield investment, as their dependent variable.

The empirical implementation of the model will be applied to the case of Spain. Spain experienced a rapid growth in FDI following its 1986 entry into the European Community. The country is an active recipient in the world flow of FDI, doubling its participation from 3.7% in the period 1981-1986 to 7% in 1991 (OECD, 1991). Whereas, at the beginning of the seventies, FDI accounted for approximately 2% of gross fixed capital formation, twenty years later, at the beginning of the nineties, the figure was 9%. Spain, thus, shifted membership from the group of countries in which the incidence of FDI on gross fixed capital formation was low to the group in which the incidence could be considered high. Venables et al. (2000) shows that at the beginning of the 1970s, 5.8% of all EU manufacturing was located in Spain. Over the last three decades this share has raised to 6.5%. The UNCTAD World Investment Report (2002) predicted that Spain would be the fifth most popular EU location for transnational corporation investment in the period 2002-2005.

There is no doubt that an intensive process of spatial concentration occurred in the regional distribution of FDI in Spain during the nineties. Table 1 depicts the geographical pattern of regional FDI in manufacturing industries; the figure shows the percentage of manufacturing FDI during the period 1995-2000 by region. Of the 17 regions, two - Madrid and Cataluña - received almost 70% of

manufacturing investment and this share rises to 90% if we add four more regions: Asturias, País Vasco, Comunidad Valenciana and Andalucía. This degree of concentration suggests that agglomeration economies are acting as crucial location factors. One difficulty we face, however, in this geographical analysis concerns the area, which is extremely large for observing agglomeration (see map of regions in the appendix). Indeed, a smaller area would be a more appropriate way for studying this question if data at that level were available. Others studies have also used the region and/or the state to analyse the determinants of FDI, including agglomeration factors (Coughlin et al 1991, Head et al. 1993 and 1995, Shaver 1998, Chung and Alcácer 2002, among others). In the case of Spain, employing the region as the unit of analysis has the advantage that the information obtained from the study can be used by regional public policy makers, whose decisions in this field are autonomous from those of central government. Thus, while it would be desirable to reduce the level of geographical aggregation, data on specific investment by firm is not available. Yet, Spain still provides a good example of a country in which to study how the inter-industry differences affect different agglomeration economies in the location of FDI. Particularly if we bear in mind that the two regions - Madrid and Cataluña - that concentrate almost 70% of manufacturing investment are relatively small.

In the estimated econometric model, FDI depends on regional characteristics (location factors), which are described in Table 3 of the appendix, and on sector characteristics (agglomeration factors), which quantify the extent to which specific industries concentrate in a certain territory. Below, we describe, first, how the dependent variable is constructed (as a proxy of FDI) and, second, the proxy variables that have been used in explaining the estimation of the econometric model.

The dependent variable

The measurement of a region's inward investment is not easy. In Spain, foreign investment data broken down by regional destination is provided by the Department of Trade and Investment. Royal Decree 664/1999 introduced modifications concerning foreign investment, which in turn affected the availability of FDI statistics in Spain. The decree ruled that potential projects were no longer subject to advance verification or authorization, but rather firms had now to declare foreign income to the Register of Investment (Ministry of Economy) once it had been invested[3]. The Department of Trade and Investment's information is drawn from this Register. These changes mean that the information is now much more reliable as all foreign investments are registered (not just foreign investments subject to verification or authorization). An investment must be registered within a month of its having been made.

In July (2003), the Department of Trade and Investment presented a new series of statistics, one of them was the "gross effective foreign investment". The Effective Gross FDI is obtained by subtracting from the registered value of gross foreign manufacturing investment: first, the acquisitions of shares by foreign investors from other non residents in Spain, and second, the multiple accounting of this same operation caused by the restructuring of business groups in Spain. Obviously these last two operations do not represent an increase in foreign assets in Spain.

The paper considers as dependent variables the effective foreign direct investment in 8 different industries: food and beverages, chemicals, transport equipment, paper, printing and publishing, metal products, electric equipment, and electronic equipment. These variables are considered the nearest proxies to FDI for the period 1995-2000. The variables are expressed per capita and in real terms.

The different industries used in the analysis was chosen using two criteria. The first criterion seeks to answer the question as to what kinds of industry are attracted to the Spanish regions. The industry share in total FDI in manufacturing should reveal this, whereby a higher share implies that these industries are more attracted to the Spanish regions than those with a lower share.

The other criterion is the relationship between the industry trait and the hypothesis that we are testing. In terms of the first hypothesis, therefore, the firm traits we are concerned with are forward and backward linkages. Venables et al. (2000) identify industries with high, medium and low intra-industry and inter-industry linkages[4], For example, the motor vehicles sector has a high level of intra-industry and a medium level of inter-industry linkages, whereas the motorcycles sector has a low level of intra-industry and a high level of inter-industry linkages. In terms of the second hypothesis, Chung and Alcácer (2002) identify the industries with the highest R&D intensity[5] as pharmaceuticals, semiconductors, chemicals, and electronics/electrical equipment, while Kuemmerle (1999) claims that pharmaceuticals and electronics, followed by the chemical, vehicle and machinery industries, are the most active in FDI in R&D. In terms of the third hypothesis, Venables et al. (2000) identify the food and beverages industry as being low technology, and with a high orientation to final demand. Table 2 shows the share of FDI by industry in 2-3 digits of CNAE (National Classification of Economic Activities) and the firm traits of each industry.

Explanatory variables

The explanatory variables are proxies for the regional characteristics that are believed to determine the choice of location. The regional characteristics considered in this paper are: market demand,

labour market, regional technical activity, manufacturing activity, same industry activity and concentration of services.

- The variables related to market demand, including size and growth rate, have traditionally been considered critical determinants in host countries, and are frequently included in studies of FDI location. Their significance and value are expected to correlate positively with FDI. The most frequently used variable as a proxy of market demand is regional income[6] (GDP). Coughlin et al. (1991) suggest a further variable that might serve as a proxy for market demand is manufacturing density. The authors point out that states with a higher degree of manufacturing activity might attract foreign investors who are already serving existing manufacturers in the area. A problem arises, however, when we introduce these two proxies (GDP and manufacturing density) in the same regression model because they are highly correlated, and so we are unable to extricate the factors we are measuring, namely attraction to final consumers - which we try to proxy through GDP - and the agglomeration economies generated by forward and backward linkages (workers seek a location near the producers of consumer goods and producers want to concentrate where the market is largest)[7].

Therefore, rather than using GDP, the variable introduced to proxy market demand will be per capita consumption (apparent consumption)[8,] leaving manufacturing agglomeration to proxy agglomeration economies generated by forward and backward linkages. The lower correlation enables us to separate market size from agglomeration economies. However it is still not possible to disentangle both effects completely, because, as discussed above, market size is clearly a fundamental factor in the appearance of specialized firms operating in complementary activities, which in turn generate productive relationships between the firms: backward and forward linkages. Thus, market size and linkages are clearly very closely related. Table 3 shows the description of the explanatory variable. A positive/negative sign is expected in the industries that are/are not final demand oriented.

- The labor market of the region is approached by labor cost and human capital. When technology levels and product quality are standardized, and cost is the priority, production may be transferred to another area with lower labor costs (Vernon, 1966). Thus, labor costs can act as a deterrent to FDI[9]. A negative sign is expected in the industries that are very oriented to costs.

However, elsewhere, labor costs would appear to have a significant positive correlation with FDI[10]. In these studies, it seems that labor costs reflect the availability of skilled workers in the region, acting as a proxy for qualifications and skills. That is, a positive sign is expected in the industries that are high technology level and look for skilled labor.

Here, two variables for labor costs were used: a) the regional value of industrial wages[11] per employee, in real terms, and b) unit labor cost measured by the ratio of industrial wages to labor productivity (value added per employee), in real terms. However, the best results were obtained using the former (see Table 3).

The availability of a skilled labor force, or skilled human capital, is important in attracting FDI, especially in manufacturing activities, and more specifically when this investment is made in technology-intensive activities of medium to high demand. Porter (1988) claims that multinational firms attach greater value to the existence of labor with a good knowledge level than to a cheap labor market, which makes it a relevant labor market characteristic of FDI in developed regions. The proxy for human capital will be the percentage of the labor force having completed higher education. A positive sign is expected in the industries that are R&D intensive (see Table 3).

The variables that seek to proxy regional characteristics, such as technical activity, manufacturing activity, same industry activity and concentration of services, are considered as being agglomeration variables and the analysis of their role in the attraction of manufacturing FDI is the focus point of this paper

- Knowledge is an important source of ownership advantage for multinationals investing in foreign regions and countries, and so R&D spending may not represent a barrier to foreign firms (Driffield & Munday, 2000). On the contrary, it may be an attraction. As a proxy for this variable we used two regional data sources: the number of patents, as a measure of innovative output; and firms' internal expenditure on research and development activities, assumed to be a key input in generating new knowledge. As the correlation between the two variables was 0.9, we selected firms' R&D expenditure, primarily because the data series were longer and more homogeneous, and because the variable values are more accurately allocated to the region in which the expenditure occurs, rather than to the Spanish headquarters in Madrid. This variable is expressed in constant terms (see Table 3). This proxy can be expected to be positive and significant in industries that have a high R&D intensity, thereby demonstrating the importance of agglomeration by technical activity in FDI location.

- The presence of existing manufacturing activity in a region, with its large cluster of consumers and suppliers, has often been considered a significant factor in attracting firms whose demand for specialized labor and other inputs is low, but which seek to locate in areas with a strong industrial heritage. This region characteristic will attract to industries with a good level of inter-industry linkages showing the importance of manufacturing agglomeration in FDI location. Here, we use the manufacturing employment rate per square kilometer as the proxy (see Table 3).

- Industry-specific agglomeration. As mentioned above, locating a firm in an area in which there is a high concentration of enterprises from the same industry can be beneficial as specialized inputs of labor, raw materials and intermediate goods are more readily available. This increases the efficiency of production and generates strong forward and backward linkages in an area. That is, industries with a medium and high level of intra-industry linkages will be attracted to the regions with high location economies. The proxy for this external economy is the share of regional industrial employment in each sector (see Table 3).

-Concentration of services is the variable that better measures the urbanization economies, as they are external economies generally related to the concentration of services (professional, banking and communication services, and the provision of scientific and technological assets) in urban areas. The proxy for concentration of services is population density. A positive and significant effect on foreign investment would imply that high population density acts as a centripetal force and so urbanization economies attract FDI, but in the case of a negative and significant effect population density might act as a centrifugal force, reflecting a congestion diseconomy.

METHODOLOGY AND ESTIMATION RESULTS

Methodology

Given the fact that we have access to panel data, as well as cross-sectional and temporal information, the methodology adopted for the model estimation is that specifically designed for panel data. The data provide information for 17 regions over a six-year period (1995-2000). The model estimated is the individual effect with panel data, that is:

$$y_{it} = \alpha + x_{it}\beta + \alpha_i + v_{it}, \quad (1)$$

where y_{it} is the dependent variable measured in region i=1,...N for the year t=1;...,T, x_{it} is a row vector of explanatory variables, α_i describes the individual effect for the regions and v_{it} is the random error, that is normal with mean 0 and variance σ_v^2.

Here, the dependent variable is FDI for the region i in the period t, and the explanatory variables are those described in Table 3. All variables are expressed in logarithm form.

The estimation of the model expressed in (1) depends on the α_i characteristics. If we suppose that α_i is a constant for each region, we can then estimate the fixed effect model - that is, the model with

binary variables for each region or the model expressed in differences with respect to the mean for each region. In both cases the estimation uses the ordinary least squares technique (OLS).

Table 4 shows the correlation matrix between explanatory variables referring to regional characteristics. This Table shows the multicollinearity difficulties encountered when interpreting the results. We observed a positive and strong correlation between population density and manufacturing density (0.884). This means that both parameters associated with these two variables appear with opposite signs. In general the parameter associated with manufacturing density is positive and significant.

The results of the fixed effect estimation are shown in Table 5. Each column corresponds to a separate industry. The last two rows in Table 5 show the R-square coefficients for each industry. All the coefficients are over 0.5, with the exception of food and beverages where the value is 0.464. The F statistic for the fixed effect shows that these effects are significant for each industry, with the exception of the electronics industry; although a significance value close to 0.1 was recorded.

The properties of the fixed effect estimation are consistency rather than efficiency. This lack of efficiency of the fixed effect estimation can mean that the parameters estimated are not significant. The efficient estimation is the random effect model.

The random effect model supposes that α_i is a random variable with normal distribution; its mean is 0 and its variance is σ_α^2. The random error in this model is $u_{it} = \alpha_i + \nu_{it}$, the variance and covariance matrix of u_{it} error are not spherical, in this case we use a generalised least square to obtain the estimated parameters.

The results for the random effect model are shown in Table 6. This estimation is efficient but it might not be consistent, which would cause the values of the estimated parameters to be very different from those of the theoretical parameters. The last row of the Table shows the R-square coefficients. Here, again all values are, in general, over 0.5. At the same time, we calculated the χ^2 statistic associated with Hausman inference. This statistical test compares the value and variance of estimated parameters with both individual effects models, fixed and random. When the differences between parameters are great and the differences between variances are small, the Hausman statistic is large and significant and the fixed effect model is preferred. When the opposite is the case, the random effect model is preferred. For all industries, the Hausman inference recommends the random effect

model, however, in what follows we do not discard the fixed effect model in seeking to prove the consistency of certain results.

Estimation Results

The empirical results obtained from the regression analyses for the specific industries show that the food and beverages industry (Table 6, column 2) is sensitive to labor costs and to technical activity. The final variable, the technical activity of the region, appeared positive and significant (level 10%) in the random effects model, which shows that regions with more FDI in their food and beverage industries (as Extremadura, Andalucía, Canarias and Castilla-León) coincide with regions that have experienced a quick and high growth in their firms' internal expenditure on R&D activities (410%, 93%, 187% and 117% respectively), while the regions that have traditionally been intensive in R&D activities (Cataluña and Madrid) only experienced an 85 and 52% growth respectively.

This result suggests that the food and beverages industry is mainly interested in low labor costs, but that it is not interested in lower wages in the food and beverages industry, because when the specification is run with this variable the result is not statistically significant. This, perhaps, is unsurprising as FDI is not attracted by location economies in the food and beverages industry. This industry ignores the rest of agglomeration economies and market proximity

As Table 2 shows, the specific industry traits of the food and beverage industries are a low level of technology, medium-high level of linkages, medium level of skill intensity and high final demand orientation, but our results show that the most important industry trait in FDI location is labour intensity, and hence labour costs.

The results for the chemical industry are shown in Table 6, column 1. Unlike the food and beverages sector, the chemical industry is sensitive to agglomeration economies. Location economies, measured by agglomeration in chemical industries, was positive and significant when the model was run with fixed effects [12.] As Fujita, Krugman and Venables (1999) claim, manufacturers seek to locate near their suppliers and their customers. Manufacturing activity was also positive and significant in the random effect model. These two variables demonstrate the importance for industrial FDI of forward and backward linkages.

Unlike the food and beverages sector, the chemical industry does not seem interested in labor costs: chemical wages, or industrial wages[13]. Urbanization economies, measured by population density, are not significant either. Table 2 shows the industry traits for the chemical industry, which is divided in

two sectors: the chemical and pharmaceutical industries (drugs and medicines). Here, this distinction was not possible because segmented data were not available. This means that the results probably include both traits: the high intra-industry linkages of the chemical industry and the high inter-industry linkages of the pharmaceutical industry demonstrating that in chemical FDI, manufacturing agglomeration and location economies are decisive location factors.

In the case of the paper industry (Table 6, column 6), the manufacturing activity variable was positive and significant, which contrasts with its industry trait (Table 2), namely a low level of inter-industry linkages. By contrast, in printing and publishing (Table 6, column 5) this variable seems to agree with its industry trait: high intra-industry linkages, showing a positive and significant value for the same industry agglomeration variable. With the exception of skill intensity (human capital proxied by education in our model), the remaining industry traits for the two sectors are similar (low technology and low final demand bias level) and they are also consistent with our non significant results. The case of metal products (Table 6, column 3) is very similar to these last two industries, as the industry traits are similar (low technology and low final demand bias level) with a low level skill intensity. In this sector, the variable manufacturing activity was positive and significant indicating that manufacturing agglomeration is a key location factor. Thus, our results confirm that in the case of these three industries, where linkages are a distinctive industry trait, either manufacturing agglomeration or location economies appear as key location factors.

Columns 4 and 8 show the results for the transport equipment and electrical industries. These results contrast with the situation in all other sectors, where we even found multicollinearity. The parameters that were found to be relevant were significant in the random effect model estimation, but in the case of transport and electrical industries multicollinearity means that the parameters associated with the variables that have a determining influence on FDI appear as being non significant. It is well known that the solution for multicollinearity is not easy. Alternative estimation methods are biased and difficult to obtain. For this reason, the easiest way to proceed is to eliminate the variables that cause the multicollinearity. In the cases of the transport and electric industries, this means eliminating consumption and population density. The results without these variables are presented in Tables 5 and 6 columns 4 and 8. In both cases the Hausman contrast recommends the interpretation of the random effect model in Table 6.

The transport sector (Table 6, column 4) is one of the industries that best adapts to the objective of this paper. Here again, we were not able to separate the sector into its two parts: motor vehicles and motorcycles, so the results no doubt include both traits. The high level of intra-industry linkages (Table 2) is reflected in the positive sign and significant value of the same industry activity variable, the high

level of inter-industry linkages is reflected in the positive sign and significant value of manufacturing density and its low level of skill intensity pulls the sector to regions with low labour costs, the parameter for which parameter is negative and significant. Thus, our results show that in the transport equipment sector, its industry traits determine its FDI location which is primarily attracted to regions with high agglomeration economies and,to those with low labour costs.

Finally, the electronics and electric industries appear in Table 6, columns 7 and 8 respectively. Both industries have very similar traits. In the electronics industry human capital, manufacturing activity and same industry activity are positive and significant. These results coincide broadly with its industry traits (Table 2): high level of skill intensity and medium level of intra-industry linkages, contrasting with a low level of inter-industry linkages. The electric industry shows that intra-industry linkages and inter-industry linkages are important industry traits in its FDI location preferences. The parameters for manufacturing density and the same industry activity present a positive sign and a significant value. Undoubtedly, in the electronics and electric industries agglomeration and location economies are decisive FDI location factors; however, by contrast, the concentration of services, proxied by population density, is negative and significant in the electronics industry. This, as Bartik (1985) points out, probably reflects congestion costs.

Thus, in the case of FDI in manufacturing activities, centripetal forces, such as the manufacturing agglomeration and location economies are more important locational determinants than are centrifugal forces, such as labor costs and congestion costs[14].

The nature and importance of FDI locational determinants varies with the specific needs of each industry. How well do these results support our three initial hypotheses?

In the case of the first hypothesis, our results show that the existing level of manufacturing activity attracts FDI to locations that are near existing manufacturers and near new potential consumers. The industries attracted by these manufacturing agglomeration and location economies are those with medium-to-high levels of intra-industry and/or inter-industry linkages, and include the chemical, transport, paper, printing and publishing, metal, electronics and electric industries. The only exception to this hypothesis is the food and beverages sector, which is attracted more strongly by labour costs.

In the second hypothesis we expect that firms in R&D intensive industries are attracted to locations of greater technical activity or, in some cases, to locations with market opportunities.Our findings fail to confirm its veracity; on the contrary, they refute it. In all industries the R&D activity variable is not significant. In the electronics industry, human capital (education) was positive and significant, which

might indicate that the higher R&D intensity of the sector values the presence of skilled labour, but despite this outcome the R&D activity variable was not significant. These results suggest that knowledge seeking is not prevalent across industries. Chung and Alcácer (2002) results suggest that only a sizeable minority of investment into the United States is seeking technical knowledge, and this behavior occurs in knowledge-intensive industries (pharmaceutical, semiconductor and electronic), within these high R&D industries, most firms that come from country-industries with below average R&D intensity are attracted to states with greater R&D intensities. It would be interesting to compare the R&D intensity of foreign firms operating in R&D intensive industries with their Spanish counterparts. Martín (1999) sheds a certain light on this question by providing a comparison of the R&D expenses of firms, divided by its added value, in Spain, the European Union (15 countries) and the United States for the period 1986-1998. When applying this index to all the sectors of the economy, the following percentage values were recorded: 0.88 for Spain, 1.91 for the EU and 2.64 for the United States, indicating that the R&D intensity of European Union firms is, on average, more than twice the figure for Spanish firms, while that of the US firms is three times the R&D intensity recorded in Spain. The author points out that this difference is concentrated above all in technology intensive industries: in chemicals, for example, the above percentages are 3.88 for Spain, 11.80 for the EU and 10.79 for the United States; in the case of the electric industry the percentages are 4.94 for Spain, 14.15 for the European Union and 14.81 for the United States; and, finally, in the case of the electronics industry the percentages are 6.43 for Spain, 11.09 for the EU and 27.99 for the United States. These results are particularly significant for this study because the European Union countries account for 68% and the United States for 23% of FDI during 1995-2000 period.

Kuemmerle (1999) uses a very similar variable (the difference in gross expenditure on R&D divided by gross domestic product between the target country and the FDI source country) to proxy the relative strength of the target country science base. The author proves that laboratories of firms in pharmaceutical and electronic industries that look for augment its knowledge base tend to choose countries where science base is relatively well developed.

These differences in R&D intensity between Spanish and foreign firms within the same industry indicate that seeking knowledge is not an FDI location determinant in these industries and that rather linkages seem to have more weight as a location pull in the chemical and electronics industries. In this sense it could be argued that FDI in R&D intensive industries is attracted to regions in order to exploit their firm specific-capabilities in foreign environments (Kuemmerle, 1999), rather than being attracted by the regions' R&D activities themselves. Spanish regions do not generate sufficient knowledge externalities to attract firms that need to augment their knowledge base, on the contrary they attract firms that want to exploit their capabilities. Therefore regions with high rates of manufacturing activity

and a high concentration of the same industry activity attract FDI in their chemical and electronic equipment industries, because producers wish to locate near their suppliers and customers.

The third hypothesis refers to industries that are particularly labour intensive, with low levels of demand and low levels of technology, such as food and beverages, metal, printing and publishing, and paper. Among these industries, only in the food and beverages sector was FDI location found to be attracted by cost factors, such as labour costs. In the other three industries (metal, paper, printing and publishing), agglomeration variables, measured by manufacturing activity and the concentration of the same industry activity, were more powerful factors of attraction.

CONCLUDING REMARKS

Agglomeration factors are not often included in studies of FDI locational determinants. Most empirical studies working with data from the '60s, '70s and early '80s found that FDI was, at that time, mainly in greenfield form, and was resource-and market-oriented. However, during the last two decades, FDI has undergone steady changes and as it has become more and more oriented towards strategic assets, such as intellectual capital, its location needs have also changed. In the case of strategic investment, the objective of which is to maintain and increase ownership advantage, the external economies generated by agglomeration factors have increased their weight in location decisions. The economic and institutional facilities offered by these new locations are also important. Thus, as Dunning (1998) suggests, while globalization separates ownership and the location of production geographically, agglomeration forces concentrate activity within particular regions and countries.

This study has sought to analyse the role played by industry traits in regional FDI location. Differences in these traits, including capital intensity, labour intensity, R&D intensity, linkages and market orientation, determine differing propensities to agglomerate. Regional characteristics, particularly those that generate agglomeration economies, act as location pull factors in function of these industry traits. In general, our hypotheses consider that, first, industries with a high level of linkages will value the existence of location economies and manufacturing agglomeration; second, firms seeking to augment their knowledge will value locations that offer greater technical activity, while firms that seek knowledge in order to exploit their capabilities will value market opportunities more positively; and, third, industries that are especially labour intensive, with low levels of demand and low levels of technology will not be interested in agglomeration economies or the size of the region’s knowledge base, but rather will seek low factor costs.

The methodology used here is that specifically designed for use with panel data. The model estimated is that of the individual effect with data panel for each industry. The Hausman inference recommends applying the random effect model; however, the fixed effect model was used to in order to verify the consistency of some of the results.

When implementing the model, a number of problems were encountered with variables that approach market demand and manufacturing agglomeration. These two variables were very difficult to disentangle and so their proxies, GDP and manufacturing density, were highly correlated. To reduce this correlation, we introduced per capita consumption instead of GDP to proxy market demand. This enabled us to separate market size from agglomeration economies.

Our empirical results show that industries with medium-to-high levels of linkages are attracted to locations with a high degree of manufacturing agglomeration and/or location economies. By contrast, firms in R&D intensive industries are not attracted to locations of greater technical activity, suggesting that knowledge seeking is not prevalent in these industries, given the relatively lower level of R&D intensity of Spanish firms. Firms in R&D intensive industries (chemicals, electrics and electronics) are attracted to locations where manufacturing agglomeration and location economies are significant, suggesting that firms seek to exploit their specific capabilities through FDI. Among the labour intensive industries, with low levels of demand and low levels of technology, only in the food and beverages industry was FDI location influenced by cost factors. In the other three industries - metal, paper and printing and publishing - agglomeration variables, including manufacturing agglomeration and location economies, were found to attract FDI. Overall, our results highlight the importance of industrial heterogeneity in influencing FDI strategy.

The findings reported here have important implications for firms. This paper demonstrates that regional characteristics are valued differently according to a firm's traits, and so new entrants can compare the industry traits of previous foreign entrants, when they are searching for a new site. In this way, they can benefit from the experience of previous foreign investors. For policy makers concerned with promoting foreign direct investment, manufacturing agglomeration and location economies are key characteristics in attracting manufacturing FDI to a territory. This paper also suggests that FDI in R&D intensive industries is actually more interested in adapting their products to the local market and so manufacturing agglomeration and location economies act as determinants of location. If public policy makers wish to shift gradually from FDI in R&D intensive industries oriented towards exploiting their capabilities to FDI that is more oriented towards augmenting their R&D capabilities, then they need to create an attractive national and local environment, which can be achieved mainly through the creation of an adequate scientific base.

In the European Union, where national boundaries are becoming less important, regional factors would appear to be gaining in importance as determinants of investment location. Consequently, more regional empirical research is needed in a number of areas. One line of study, once the information becomes available, is the analysis of the role of regional incentives in location decisions. Another is to explore the role that specific foreign agglomeration economies play as location factors. Finally, there is a need for further research into location preferences for plant investment.

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Notes

1- This phenomenon is reflected in the increasing number of mergers and take-over.

2- This paper does not focus its attention on this specific kind of FDI agglomeration since this would require knowing the exact number of establishments or plants. Alternatively, we could use the annual stock of accumulated manufacturing FDI, but these figures are not available.

3- Except in some special cases of investment originating from tax havens, in which case the declaration has to be made prior to the investment.

4- Venables et al. (2000) identify the characteristics of industries for 13 EU countries and 36 industries, from 1970 to 1997, using OECD STAN database and OECD input-output tables’ database. Among others, the industry traits comprises economies of scale, technology level (high, medium and low), intra-industry linkages (use of intermediates from own sector as share of value of production), inter-industry linkages (use of intermediates excluded inputs from own sector, as share of value of production), and final demand bias (percentage of sales to domestic consumers and exports).

5- Those industries whose R&D spending /sales is over 5% for OECD nations

6- Scapelanda and Baloug (1983), Culem (1988), Head et al., (1999); Woodward (1992), Thiran and Yamawaki (1995), Mariotty and Priscitello (1995), Chung and Alcácer (2002), Bajo-Rubio and López-Pueyo (2002). All these studies reported a positive and significant correlation between GDP and FDI.

7- Head et al. (1999) found a correlation between demand (GDP) and manufacturing agglomeration of 0.9, and Mariotti and Priscitello (1995) recorded a strong correlation between the metropolitan areas of Milan and Rome and R&D, wages and market.

8- Mariotty and Priscitello (1995), and Bajo-Rubio and López-Pueyo (2002), use per capita consumption as proxy for market demand. The authors found a positive and significant correlation with FDI.

9- Bartik (1985), Luger and Shetty (1985), Hill and Munday (1991), and Coughlin et al., (1991), reported a negative and significant correlation between wages and FDI.

10- Head et al., (1999), Thiran & Yamawaki (1995), and Guimaraes et al., (2000), obtained a positive and significant correlation between wages and FDI.

11- Wages includes all labor costs such as unemployment, illness and disability insurance costs.

12- An inconsistency was detected in the random effect estimation of this parameter. Therefore, although the random effect model is more appropriate, according to the Hausman test, for the parameter associated with agglomerations in the chemical industry, the fixed effect model provides better results in terms of efficiency as well as bias.

13- When the specification is run with industrial wage, the variable was also not significant.

14- Some of these results broadly coincide with those reported by Luger & Shetty (1985). The latter analyzed the effect of agglomeration economies, urbanization economies, and labor market conditions on FDI in three industries: drug manufacturing, industrial machinery, and motor vehicle production. They found agglomeration economies, measured as the total number of annual man hours in a specific industry, to be positive and significant in the three industries. Urbanization economies, measured by population density, were not significant in the three industries. The quality of the labor market, measured as the percentage of white collar workers in the labor force, was reported as being positive and significant in the motor vehicle sector, but negative and not significant in the other two

industries. Finally, labor costs, measured as the wage rate in each industry were negative and significant in the three industries. Here, in our study, this variable was only negative and significant in food and beverages and not significant in chemicals and transport equipment.

Appendix

Map of Spanish Regions

Table -1

Regional distribution of manufacturing foreign direct investment

Region	%
Andalucía	3,17
Aragon	1,57
Asturias	7,36
Baleares	0,11
Canarias	0,25
Cantabria	0,03
Castilla-León	0,92
Castilla-Mancha	0,76
Cataluña	31,99
C-Valenciana	4,38
Extremadura	0,46
Galicia	1,00
Madrid	37,30
Murcia	1,05
Navarra	2,22
Pais vasco	6,72
La Rioja	0,68
Total	100,00

Table 2

Share of FDI by industry and Industry characteristics

Industry	% manufacturing FDI by industry
Chemicals	21.95
Food and Beverages	14.96
Metal Products	10.73
Transport Equipment	8.23
Printing & Publishing	8.05
Paper	5.21
Electronic Equipment	5.81
Electric Equipment	4.71
Total	79.65

Industry traits

Industry	Technology level	Intra-industry linkages	Inter-industry linkages	Skill intensity	Final demand bias
Chemicals					
- Ind. Chemicals	M	H	L	H	M
- Drugs & Medicines	H	L	H	H	H
Food and Beverages	L	M	H	M	H
Metal Products	L	M	M	L	L
Transport Equipment					
- Motor vehicles	M	H	M	L	H
- Motorcycles	M	L	H	L	L
Printing & Publishing	L	H	L	H	L
Paper	L	H	L	M	L
Electronic Equipment	H	M	L	H	M
Electric Equipment*	H	M	M	M	M

H: High, M: Medium, L: Low *Electric Equipment doesn't include Office & Computing
Source: Venables et al. (2000)

Table 3

Description of explanatory variables, construct and measurements

Variable (Region Characteristic)	Construct (proxy) For all proxies: period 1995-2000, constant terms of 1995	Measurement
Demand	Per capita Consumption (CONSUM)	Market demand
Labor Cost	Manufacturing wages per manufacturing wage earner (WAGE)	Labor Market
Human Capital	Share of labor supply with higher education (EDU)	Labor Market
Technical Activity	Firms' internal expenditure on R&D activities (R&D)	R&D activities Agglomeration
Manufacturing Activity	Manufacturing employment per square kilometer (MD)	Manufacturing Agglomeration
Same Industry Activity	Share of regional industrial wage earners in the same industry (AGGLO)	Location Economies
Concentration of Services	Population Density (PD)	Urbanization Economies

Table 4

Correlation Matrix of Independent Variables*

	CONSUM	PD	EDU	WAGE	R&D	MD
CONSUM	1.000	0.417	0.209	0.725	0.389	0.631
PD		1.000	0.475	0.348	0.393	0.884
EDU			1.000	0.305	0.865	0.445
WAGE				1.000	0.535	0.502
R&D					1.000	0.532
MD						1.000

* All correlations are significantly different from cero

Table 5

Estimated parameters in fixed effect model
(t statistical in brackets)

Variable	Chemicals	Food and Beverages	Metal Products	Transport Equipment	Printing & Publishing	Paper	Electro. Equip.	Electric Equip.
COMSUM	3.462	0.261	-4.867	7.056	-4.915	-25.481	-11.994	-5.005
	(0.186)	(0.014)	(-0.217)	(0.328)	(-0.244)	(-1.413[c])	(-0.621[c])	(-0.236)
PD	-2.498	-0.072	-0.802	-1.371	-1.018	-0.865	-4.423	1.969
	(-1.172)	(-0.040)	(-0.315)	(-0.558)	(-0.442)	(-0.418)	(-2.010[b])	(0.816)
EDU	4.032	-1.044	3.117	5.970	-0.562	-4.496	3.566	-3.175
	(0.735)	(-0.225)	(0.479)	(0.947)	(-0.095)	(-0.849)	(0.631)	(-0.512)
WAGE	-4.152	-28.022	-5.354	-22.858	4.016	37.756	5.063	6.199
	(-0.151)	(-1.206)	(-0.165)	(-0.665)	(0.134)	(1.407[c])	(0.175)	(0.196)
R&D	-1.121	0.655	1.041	-2.002	0.119	0.609	0.332	-1.548
	(-0.721)	(0.496)	(0.566)	(-1.117)	(0.069)	(0.396)	(0.206)	(-0.876)
MD	-6.076	3.904	15.316	-8.672	9.774	11.514	6.590	14.577
	(-0.551)	(0.434)	(1.221)	(0.668)	(0.846)	(1.110)	(0.598	(1.207)
AGGLO	6.974	-11.266	-13.573	-6.235	5.054	0.724	8.219	-2.246
	(1.303[c])	(-0.595)	(-0.998)	(-0.481)	(0.663)	(0.106)	(1.417[c])	(-0.353[c])
Constant	0.719	-1.534	-16.997	-15.273	10.702	68.663	43.918	1.618
R^2	0.660	0.464	0.560	0.613	0.598	0.696	0.603	0.609
FE Test	3.252[a]	2.058[b]	1.715[c]	3.356[a]	1.987[b]	2.363[a]	1.469	2.030[b]

[a] Significance at 1%. [b] 5%. [c] 10%.

Table 6

Estimated parameters in random effect model
(t statistical in brackets)

Variable	Chemicals	Food and Beverages	Metal Products	Transport Equipment	Printing & Publishing	Paper	Electronic Equip.	Electric Equip.
COMSUM	0.670	-0.546	-1.506		0.276	-2.046	1.425	
	(0.223)	(-0.438)	(-0.475)		(0.100)	(-0.871[c])	(0.504)	
PD	-2.866	-0.131	-3.910		-0.968	-1.236	-3.809	
	(-1.026)	(-0.067)	(-1.149)		(-0.327)	(-0.501)	(-1.547[c])	
EDU	2.043	-1.274	1.294	0.968	3.142	1.945	3.211	1.258
	(0.724)	(-0.725)	(0.382)	(0.282)	(1.023)	(0.757)	(1.360[c])	(0.317)
WAGE	-11.637	-14.233	0.851	-14.982	-6.494	-3.947	-10.237	-8.311
	(-0.905)	(-1.949[b])	(0.054)	(-1.372[c])	(-0.504)	(-0.361)	(-0.885)	(-0.901)
R&D	0.346	1.806	0.985	0.372	-0.918	0.653	-1.259	0.093
	(0.162)	(1.410[c])	(0.432)	(0.154)	(0.440)	(0.375)	(-0.721)	(0.049)
MD	3.775	0.591	4.065	2.478	1.954	3.121	5.373	1.905
	(1.367[c])	(0.294)	(1.300[c])	(1.250[c])	(0.680)	(1.294[c])	(2.361[a])	(1.250[c])
AGGLO	2.558	-1.173	3.605	2.684	4.865	2.640	3.394	4.399
	(0.978)	(-0.448)	(0.856)	(1.420[c])	(1.436[c])	(0.910)	(1.461[c])	(2.976[a])
Constant	0.719	-0.003	0.006	-0.016	-0.006	0.004	-0.005	-0.013
R^2	0.656	0.447	0.538	0.589	0.589	0.674	0.592	0.591
Hausman Test	6.407	5.399	4.492	2.899	6.855	6.038	0.067	2.138

[a] Significance at [a] 1%. [b] 5%. [c] 10%.