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## Regional distribution of foreign manufacturing investment in Spain. Do agglomeration economies matter?

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# **Regional distribution of foreign manufacturing investment in Spain. Do agglomeration economies matter?**

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## **Introduction**

The process of globalization, in particular the increasing international economic integration induced mainly by new technology, the reduction of transport costs and trade barriers, and the liberalization of an increasing number of economic sectors, underlies the restructuring of international production.

Multinational firms, as the main subjects of foreign direct investment, are at the heart of this globalization process. Foreign direct investment has played an important role in the development and modernization of the Spanish economy (Iranzo, 1991; Martínez Serrano & Miro, 1992; Merino and Salas, 1995; Martín & Velázquez, 1996a). It is decisive as a complement of national capital, technology and know-how, and has a strong influence on the economic and social environment.

The objective of this paper is to examine the nature and determinants of FDI in Spanish regions, with special emphasis on agglomeration factors. The paper focuses on manufacturing investment, as a key factor in the economic transformation of the last 35 years, and traditionally the main part of FDI until the mid-eighties. The analysis also considers three separate industries in order to test the hypothesis that the importance of the location determinants varies according to specific industry needs. These manufacturing industries are food and beverage, chemical and transport equipment, and represented altogether the 51 percent of all foreign manufacturing investment for the period 1993-2000<sup>1</sup>. Those industries have 1993 CNAE (National Classification of Economic Activities) number 15 for food and beverage, 24 for chemical, 34 & 35 for transport equipment.

The article is divided into four sections. The next section examines the location determinants of FDI. The second section discusses the variables and reviews the existing literature on regional location factors. The third section provides details on the

database, the econometric methodology and the empirical results. The final section offers summary and concluding remarks.

## **1- Location determinants**

In the literature of multinational activity determinants, the Dunning “Eclectic Paradigm” is one of the most relevant and unifying approaches. Eclectic theory suggests that direct foreign investment by an enterprise is determined by three types of advantages, named ownership-location-internalization (OLI) advantages (Dunning, 1981). These are, first, the extent to which these enterprises possess net ownership advantages (Hymer, 1960; Kildberger, 1969; Caves, 1971); second, whether it is better for these enterprises to internalize these advantages or leave them (through the market) for other enterprises to exploit (Buckley & Casson, 1976); third, whether it is profitable to locate their production units at home or abroad (Vernon, 1966).

The factors that affect a firms’ location can be divided into two groups. One group comprises all the characteristics of its home territory that give a firm comparative advantages, such as factor endowments (capital and labor) and natural resources. These could be considered traditional factors.

The second group refers to the role of external economies, i.e. increasing returns external to the firm but internal to the territory, in the location of economic activity. Marshall’s contribution at the end of the XIX<sup>th</sup> century is pioneering in this aspect. In Marshall’s view there are three types of external economies that generate agglomeration (geographical concentration): specialized labor, specific inputs and technological spillovers.

Marshall’s ideas, with more recent contributions, have led to different lines of agglomeration studies. Krugman (1991) believes that technological spillovers are invisible, leave no trace and so are difficult to quantify. Technological spillovers play an important role in industrial concentration, but are no more important than other factors such as labor and other inputs. It is the interaction between transport cost, scale economies and demand that decides spatial location. Audretsch (1998) centres his

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<sup>1</sup> Chemical represented the 21.2% of total manufacturing effective FDI, food and beverage the 15.5% and transport equipment the 14.3%.

attention on technological spillovers, identifying how knowledge spillovers promote innovative activity and economic growth within a location.

The new economic geography starts, in part, from Marshall's ideas, sharing common elements such as increasing returns, transport and congestion costs and market access. As these elements interact, they generate centripetal forces, attraction forces that encourage industry to agglomerate. However, if the forces that generate these elements are centrifugal, then firms tend to scatter. Fujita, Krugman and Venables (1999) see the main centripetal forces generating agglomeration as: 1) linkages: forward linkages (orientation of the output) and backward linkages (input requirements), 2) the existence of thick markets and, 3) knowledge spillovers. As the main centrifugal forces, they define: 1) immobile factors, such as land and labor in many cases (international cases) and, 2) congestion diseconomies. In a world where transport cost and increasing returns are important, forward and backward linkages can generate a process of agglomeration where producers want to locate near their suppliers and their customers and so, near each other. However, the immobility of some resources and congestion cost act as a centrifugal force favouring the spreading of firms. The tension between centripetal and centrifugal forces will decide the economic geography.

How does all this affect FDI in Spain? There is no doubt that an intensive process of spatial concentration occurred in the regional distribution of FDI during the nineties. For the period 1998-2000, the regions of Madrid and Catalonia received 80% of total FDI<sup>2</sup> and the 70% of manufacturing investment (Pelegrín, 2002). In both cases there is a recent tendency to locate the headquarters in Madrid, near the main policy institutions that foreign firms want to relate to, such as, for instance, the regulatory commissions for telecommunications, transport, energy, banking, etc.

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<sup>2</sup>Total FDI for 1998-2000 period includes the value of investment in holdings of foreign assets (ETVE), a capital that comes only for fiscal advantages but does not stay. This phenomenon has increased dramatically since 1999. During the 1993-1998 period, the value of foreign investment in holdings of foreign assets accounted for only 26% of foreign investment in holding assets (foreign and Spanish), but during 1999-2000 this figure jumped to 79% (which was 38% of FDI).

## **2- Variables that influence location decisions of manufacturing foreign investment**

One difficulty with this kind of studies is the non-existence of a structural model that analyzes FDI determinants and decides which ones are really relevant or which ones have to be included and which ones not. Instead, there are empirical studies that give some clues about variables, their behaviour and how they interact.

The dependent variable

Foreign direct investment involves the ownership and control of physical productive assets by foreign residents or firms<sup>3</sup>.

The measurement of inward investment in a region is not easy. From July (2003), the Department of Trade and Investment (DGC&I) presented a new series of statistics, obtained subtracting to the registered value of gross foreign manufacturing investment, first, the acquisitions of shares by foreign investors to other non residents in Spain, and second, the multiple accounting of the same operation caused by the restructuring of business groups in Spain. These last two operations do not imply an increase of foreign assets in Spain. The variable resulting is the "gross effective foreign investment"<sup>4</sup>, which is the nearest proxy to foreign direct investment for the period 1993-2000. The variable is per capita and in real terms.

To improve the analysis, we run a second regression using gross effective foreign investment in food and beverage industry, a third one for chemical industry and a fourth one for transport equipment industry, and we compare the results to find if there are significant differences in location determinants between these industries.

Independent variables

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<sup>3</sup> Influence or control in the firm exists when a foreign investor's ownership is 10% or more of capital.

<sup>4</sup> The dependent variable is specified in gross terms because the objective of the paper is the identification of the location attraction factors of FDI, not the effects that these foreign capitals have over the productive structure. To this respect is interesting specify that the effective net FDI in the manufacturing industry has recorded negative values during 1999, 2000 and 2002.

Independent variables can be divided into two groups. One group includes what we could call traditional determinants, access to markets and labor. A second group comprises variables relating to agglomeration economies, in a broad sense, such as manufacturing and services agglomeration, population density and concentration of R&D activities.

#### Traditional variables

The variables relating to market demand, such as size and growth rate, have been traditionally considered of crucial importance as characteristic determinants of host countries, and frequently included in most studies of FDI location.

The most frequent variable used to proxy market demand is regional income (GDP) (Scapelanda & Baloug, 1983; Culem, 1988; Head et al., 1999; Woodward, 1992; Thiran & Yamawaki, 1995, Mariotty & Priscitello, 1995, Martín & Velázquez, 1996b). All these studies found a positive and significant correlation between regional market and FDI.

For the Spanish case, empirical studies found a positive and significant relation between GPD and FDI, but most part of these studies were carried at sector level (Bajo, 1991; Bajo & Sosvilla, 1992; Martínez Serrano & Miro, 1992; Egea & López-Pueyo, 1991a). Bajo-Rubio & López-Pueyo (2002) test the market size for each industry, using the percentage yearly growth of the industry domestic market, approximated by the apparent consumption for each industry, obtaining a positive and significant relation. Regionally, Egea & López-Pueyo (1991b) use the regional per capita GPD and find a positive relationship with FDI, through a cluster analysis.

Nevertheless, some other studies suggest that the explanatory power of this variable tends to be lower at local level, because it is unlikely that the market served by the foreign firm coincides with the boundaries of the region considered, given easy access to neighbouring zones (Mariotty & Priscitello, 1995; Guimaraes et al., 2000). Coughlin et al. (1991) suggest that another variable that could be a proxy for market demand is manufacturing density. The authors point out that states with a higher degree of manufacturing activity could attract foreign investors who are already serving existing manufacturers in the area.

In our case we will use as a proxy for market demand the personal income at regional level, in constant terms. However, as we introduce manufacturing density into the agglomeration variables, we use this variable as another proxy of market demand.

The labor market will be described by two variables: labor cost and quality of the labor force. Imperfect labor markets and reduced labor mobility can lead to differences in real labor cost (Hood & Young, 1979). When technology and product are standardized, as the priority is cost, production may be transferred to another area with lower labor costs (Vernon, 1966). So labor cost acts as a deterrent to FDI (Bartik, 1985; Luger & Shetty, 1985; Hill and Munday, 1991; Coughlin et al., 1991).

However, in other studies labor costs appear to have a significant positive correlation with FDI (Bajo 1991; Head et al., 1999; Thiran & Yamawaki, 1995; Guimaraes et al., 2000). In this case, authors point out that labor cost probably reflects the availability of skilled workers in the region, acting as a proxy for qualifications and skills. Finally, there are some cases (Hill & Munday, 1992; Friedman et al., 1992; Woodward, 1992; He, 2002, Bajo & López-Pueyo, 2002) where labor costs appear to have no significant effect on FDI. So the empirical evidence seems rather inconclusive.

The variables most frequently used to proxy labor costs in industry are manufacturing wages, earnings and unit labor costs. In the empirical analysis two proxy variables for labor cost have been tried: a) regional value of industrial wages<sup>5</sup> 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, but the best results were obtained for industrial wages.

For the specific industries study the proxy will be the regional value of wages per employee in each industry (food and beverage, chemical and transport equipment industry), in real terms.

Quality of the labor force. The availability of a skilled labor force, or human capital, is important in attracting FDI, especially in manufacturing activities, and more specifically when FDI is direct towards medium and high demand and technology-intensive activities. Porter (1988) points that multinational firms give more value to the existence

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<sup>5</sup> Wages includes all labor costs as, for instance, unemployment, illness and inability insurance.

of labor with good knowledge level. Consequently, this is a relevant labor market characteristic of FDI in developed regions.

The generally expected sign for this variable is positive. In Woodward (1992), Japanese investors prefer counties with strong educational attainment. Educational attainment is measured by the median years of school completed by the adult population. Luger & Shetty (1985) use as a proxy the percentage of the state's employment that is classified as white collar, and the variable is positive and significant for the motor vehicle industry, but not for drug manufacturing and industrial machinery. Egéa & López-Pueyo (1991b) find that knowledge level of population is higher in the Spanish regions with more FDI. Martín & Velázquez (1996b) find a positive and significant relation between human capital and FDI between OECD countries.

However, for Bartik (1985), the educational level of the population, measured as median years of education, seems to have a negative significant effect. The author attributes this to the negative effect of wages on FDI location, captured by the educational variable, which acts as an exogenous determinant of wages.

Two proxy variables for human capital were tried in empirical analysis: percentage of the labor supply with secondary schooling and percentage of the labor supply with superior education.

#### Agglomeration variables

As explained in the previous section, one determinant of location selection is the existence of agglomeration economies, or external economies resulting from geographical concentration of economic activity. Basically there are two major types of agglomeration economies (Hoover, 1936). First, location economies, or externalities derived from industry-specific location, obtained when firms in the same industry share a pool of skilled labor and specialized input suppliers, so there are external economies to the firm but internal to the industry. Second, urbanization economies, there are external to the industry, but internal to the territory, and benefit to all the firms located in the area, generally related to the concentration of services in urban areas. Urban areas provide professional services, banking services, communication services, and scientific and technological assets.



The location behaviour of a foreign investor differs from that of a local one because of the higher information cost that the foreign investor incurs. The foreign investor's response to this information cost is to locate in more concentrated areas (He, 2002). Driffield & Munday (2000) explore the dynamic relationship between inward investment, agglomeration, improvements in the comparative advantages of industry and its role as a FDI location determinant, using two models and a panel-type approach. The authors conclude that previous FDI and agglomeration are determinants of competitive advantage for industry, and this, plus research and development and market access, determines new foreign investment.

There is not much empirical evidence for agglomeration effects on FDI. This paper tries to test four types of agglomeration economies and discusses some of the research done. The first type of agglomeration is manufacturing agglomeration, the most general one and the most used too. The presence of existing manufacturing activity in the region, with a large cluster of consumers and suppliers, has often been considered a positively related factor of attraction to firms that have a less demand for specialized labor and other inputs, but seek to locate in areas with a heritage of industrial activity (Bartik, 1985; Luger & Shetty, 1985; Coughlin et al., 1991; Woodward, 1992; Guimaraes et al., 2000; He, 2002).

To measure manufacturing density, different proxies have been used. Head et al. (1999), Woodward (1992) and He (2002) use the existing number of manufacturing establishments, Coughlin et al. (1991) and Guimaraes et al. (2000) use the manufacturing employment per square mile in the first case and square kilometer in the second. Bartik (1985) uses manufacturing hours in state per square mile and Luger & Shetty (1985) use the total number of annual production manhours. We use as a proxy manufacturing employment per square kilometer. However some authors (Head et al., 1999 and Guimaraes et al., 2000) consider this measure crude because the variable should be, at least in part, industry-specific, especially when it is the only variable used to calculate agglomeration economies.

The second type is industry-specific location agglomeration. As it was mentioned above, the location of a firm in an area with high concentration of enterprises from the same industry can benefit the firm because specialised inputs as labor, raw materials and intermediate goods are more available, increasing efficiency production and generating strong forward and backward linkages in the area.

The analysis will proxy this external economy, in the specific industry study, through three variables: food and beverage agglomeration, chemical agglomeration and transport equipment agglomeration, calculated as the share of regional industry employment in food and beverage, chemical and transport equipment respectively (Guimaraes et al., 2000).

The third type of agglomeration is urbanization economies. Service agglomeration, which usually concentrates in urban areas, can be relevant to foreign firms' location. As it is pointed above, urban areas provide professional services, banking services, communication services, and scientific and technological assets.

To proxy these urbanization economies Guimaraes et al. (2000) used Service agglomeration, calculated as the share of total employment in tertiary sectors, and obtained a positive and significant relation with foreign location.

Another variable used to proxy urbanization economies is population density. Luger & Shetty (1985), Woodward (1992) and He (2002) consider that a high population density act as a centripetal force on agglomeration, with a positive significant effect on foreign investment. However, unlike these, in Woodward (1992) the coefficient is not statistically significant. But a second possible interpretation of population density is as a centrifugal force, reflecting a congestion diseconomy, and acting as a proxy for industrial land prices. This approach was used by Bartik (1985) and Guimaraes et al. (2000). In the first case the variable had the correct sign, negative, but was not significant; and in the second case the variable was positive and statistically significant.

As population density has two possible interpretations, another variable was tried: the regional share in total, or national, population. The correlation between both variables was 0.9 and best results were obtained with population density.

In the empirical study the urbanization economies will be approximated by service agglomeration, measured by the share of total employment in tertiary sector and population density.

The fourth type of agglomeration economies is technological activities (R&D). Following Marshall's ideas of external economies that generate geographic concentration (specialized labor, specific inputs and technological spillovers), the density of innovation activity can attract manufacturing to an area. The emergence of intellectual

capital as a key strategic asset in the wealth creation process is one of the most characteristic changes in the international situation during the last two decades. The result is a progressive change in the location needs of enterprises, from traditional motives such as access to markets and natural resources, to access to knowledge-intensive assets in order to increase firms' ownership advantages (Dunning, 1998).

As geographic proximity matters in transmitting knowledge (Audretsch, 1998), a location in an area with scientific and technological assets provides access to economic knowledge spillovers. There is a theoretical debate about the regional promotion of knowledge spillovers. One line, called MAR externalities -- from the approaches of Marshall (1920), Arrow (1962) and Romer (1986) --, assumes that most learning and knowledge spillovers take place within a particular industry, the concentration of an industry promotes knowledge spillovers among firms and therefore facilitates innovative activity. An important assumption of the model is that knowledge externalities only exist for firms in the same industry. Therefore, the relevant unit of analysis can be extended from the firm to the region, following Marshall, Arrow and Romer model, but spillovers are limited to occur only within an industry (Audretsch, 1998).

On the contrary, Jacobs (1969) argues that the most significant knowledge spillovers are external to the industry in which the firm works. The exchange of complementary knowledge across diverse firms and economic agents is in the base of innovation, and cities are an important source of knowledge externalities because the diversity of these knowledge sources is greater. To Jacobs, the variety of industries in a region generates more knowledge spillovers, more innovative activity and more economic growth.

From these points of view it is not clear if technological agglomeration should be considered a location economy, in the sense of Marshall, Arrow and Romer approach, or urbanization economy, in Jacobs approach sense.

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 attractive. To proxy this variable we had two regional data sources: patents, which measure innovative output; and second, firms' internal expenditure on research and development activities (R&D), considered a key input in generating new knowledge. As correlation between

the two variables was 0.9 we selected firms' R&D expenditure, mainly because its series are longer and more homogeneous and variable values are better allocated to the region where the expenditure really occurs and not to the headquarters in Spain (Madrid). This variable is expressed in relative magnitude, divided by regional GDP, and in constant terms.

Capital effect and information costs. Lastly, we introduce two dummies for the most FDI-preferred regions, Madrid and Catalonia. The dummy for the Madrid region summarizes all the determinants not included above, such as the headquarters effect due to administrative and political capital and minimization of information cost due to previous FDI. The dummy for Catalonia also minimized information cost due to previous FDI, as it was the leading region for manufacturing FDI until the last decade. Besides, Catalonia is a coastal area, with major ports and traditionally more open to international transactions. The presence of foreign investors in these two regions acts as a signal effect to other investors, so reducing information costs (Dunning, 1998) and contributing to positive agglomeration economies.

### **3- Empirical results**

The methodology adopted has been to regress the dependent variable, manufacturing effective FDI, on the independent variables, using 17 regions and 8 years data (1993-2000) in a panel data of 136 observations. This panel data is estimated considering an individual effect, non-observed, for each region. Once the non-existence of correlation between the individual effects and the independent variables has been tested through the Hausman test, a random effect model is used and more efficient estimations made by generalised least squares (GLS). Finally, estimation by ordinary least squares (OLS) is run to introduce the two dummies, in order to measure other non-introduced variables such as capital effect and information costs.

A log-linear functional form is adopted to transform the relationship between FDI and the explanatory variables into a linear one. The regression model takes the following form, in which  $i$  denotes regions and  $t$  denotes time,  $\beta$  are vectors of regression coefficients,  $\alpha_i$  and  $\mu_{it}$  are regional random effects, time invariant, and error term time varying.

$$\text{Log FDI}_{it} = \beta + \beta_1 \text{LogDemand} + \beta_2 \text{LogWage} + \beta_3 \text{LogEducation} + \beta_4 \text{LogManufacturing Aggl.} + \beta_5 \text{LogService Aggl.} + \beta_6 \text{LogPopulationDensity} + \beta_7 \text{LogR\&D} + \alpha_i + \mu_{it} \quad (1)$$

The empirical results obtained from the regressions are shown in tables 2 and 3 (see appendix), table 2 shows the results for total manufacturing FDI analysis, and table 3 shows the results for specific industries analysis: food and beverage, chemical and transport equipment.

In table 2 appear the regression results for the dependent variable manufacturing FDI following function 1. Estimations in columns 1, 2 and 3 are obtained by generalised least squares (GLS), and estimation in number 4 by ordinary least squares (OLS) in order to introduce the dummies for Madrid and Catalonia.

Analysis of the correlation matrix for the variables (see table 4 in appendix) shows the existence of close correlation between four variables: demand (GDP), manufacturing agglomeration, education and R&D activities. These correlation are not surprising; Coughlin et al. (1991) pointed that a good proxy for market demand was manufacturing agglomeration, Head et al. (1999) found a correlation between Demand (GDP) and Manufacturing Agglomeration of 0.9, and Mariotti & Priscitello (1995) saw strong correlation between metropolitan areas (Milan and Rome) and R&D, wages and market. In addition, the areas with high level of manufacturing agglomeration and GPD are the ones with more R&D activities and with more educational level.

To solve this problem GPD is eliminated in this regression and manufacturing agglomeration used to proxy demand instead of GPD, because best results are obtained and estimation improves. In second term, every specification is used only for one of the correlated variables, so the variable manufacturing agglomeration is introduced in specification number 1, the variable education in number 2, and the variable R&D is introduced in the specification number 3. The panel of 136 observations explains 67% of manufacturing direct investment in specification number 1, 64% in number 2, and 63% in specification number 3.

Specification number 1 shows that manufacturing agglomeration and industrial wage are significant and with positive sign. On the contrary population density is significant but with a negative sign, and service agglomeration is negative and not significant.

Specification number 2 shows the results of the analysis without the variable manufacturing agglomeration and with superior education, which is positive and significant together with wages probably capturing the education effect, meaning that higher education entails higher wages.

Specification number 3 introduces R&D activities which appear positive and significant, industrial wage remains positive and significant.

Manufacturing agglomeration is significant in most of the studies mentioned, which shows, in a broad sense, the importance for industrial FDI of forward and backward linkages. As Fujita, Krugman and Venables (1999) believe, manufacturers want to locate near their suppliers and their customers.

Density of Population is negative and significant, probably reflecting congestion costs, as Bartik (1985) points out. Manufacturing investment feels more attracted to locations where population density is relatively lower, such as Catalonia, Asturias, Valencia, Navarra or Andalucía, which together accounted for around 50% of all manufacturing FDI during the period 1993-2000.

Industrial wages are positive and significant, which could be interpreted as meaning that investment goes to places where wages are high, perhaps because it is more attracted by other aspects of labor, such as quality, than by cost, so probably reflecting the availability of skilled workers in the region, acting as a proxy for quality of labor, as in Bajo 1991; Head et al., 1999; Thiran & Yamawaki, 1995; Guimaraes et al., 2000. This empirical result is consistent with the descriptive analysis: the areas that attracted more FDI per capita during the period of analysis are the same areas that recorded higher levels of wages per worker, and the same with higher education (Madrid, Catalonia and the Basque Country).

Spatial concentration of technology facilities improves productivity growth, because knowledge spillovers occur more easily. Variable R&D is highly significant, as in Yamawaki et al. (1993) and Driffield & Munday (2000). Dunning (1998) explains that a significant recent change in motives for FDI is the growth of strategic asset-seeking FDI<sup>6</sup>, in order to protect or increase the ownership advantage of the investing firm,

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<sup>6</sup> This phenomenon is reflected in the increasing number of mergers and take-overs.

rather than to exploit this advantage as in the case of traditional FDI. Thus, the location preferences of firms have changed towards more innovative activities, mainly confined to developed countries and usually more geographically concentrated than other kinds of activities.

Finally, service agglomeration is not significant, the negative sign could mean that the three regions with the highest service agglomeration (Madrid, Baleares and Canarias) don't reach the 41% of effective manufacturing FDI.

The specification number four, the last specification, is an estimation of manufacturing FDI by pooled least squares with the purpose of testing the effect of Madrid as capital and other effects not specified in the explanatory variables, and broadly summarized as information costs for Madrid and Catalonia. As Table 2 shows, the variables Madrid and Catalonia are positive and significant, there are unobserved advantages as the capital effect of Madrid and the prior cumulative FDI in Madrid and Catalonia<sup>7</sup>. It could capture too the existence of public incentives, variable that has not been included as explanatory because no reliable information was available. However, we do not believe that these dummies capture transport infrastructure<sup>8</sup>.

Consequently, in manufacturing FDI, centripetal forces, such as agglomeration of manufacturing activity, high density of innovation activities and concentration of high level education, are more important as location determinants than centrifugal forces, as population density, which reflects congestion costs.

The empirical results obtained from the regressions for the specific industries analysis are shown in table 3. Results for the dependent variable manufacturing FDI in food and beverage industry are in column 1, chemical industry in column 2 and transport equipment in column 3, estimations are obtained by generalised least squares (GLS).

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<sup>7</sup> The results of the pooled least squares were the same, (signs and significant), except for the variable population density, when estimations were run with education variable and with R&D variable instead of manufacturing agglomeration variable.

<sup>8</sup> This study tried to estimate a specification, not finally included, using an independent variable that represented the stock value of roads, railways, ports and airports by region. The variable appeared not significant in all specifications, and the dummies for Madrid and Catalonia remained significant. Finally, it was decided to remove the variable because of multicollinearity problems and because the data series was not complete.

The results of column 1 shows that food and beverage industry seems to be only sensitive to labor cost. This industry avoids location economies, because food and beverage agglomeration is negative and significant, and doesn't look interested either in urbanization economies, population density and service agglomeration are not significant. It is not interested in manufacturing agglomeration and in R&D activities either<sup>9</sup>.

Out of these columns it looks like if food and beverage industry only is interested in low labor cost, but not in lower food and beverage industry wage: when the specification is run with food and beverage industry wage, this variable appears not significant, which is not surprising because is not attracted either by food and beverage location economies. This industry seems more interested in general industrial wage, which is negative and significant. Something similar happens with education, when secondary schooling is used as a proxy of education, then industrial wages appear negative and significant, and secondary education appears too, probably the last one capturing the industry wages effect.

The results for chemical industry are in table 3, column 2. Opposite to food and beverage, the chemical industry is sensitive to agglomeration economies. Location economies, measured by agglomeration in chemical industries, are positive and significant. Manufacturing agglomeration is also positive and significant. Concentration of quality labor, measured by superior education, and agglomeration of R&D activities also appears positive and significant when the model is run with these variables instead of manufacturing agglomeration variable, which is not surprising given the high correlation between the three variables.

Opposite to the food and beverage, chemical industry doesn't seem interested in labor cost, neither chemical wages, nor industrial wages<sup>10</sup>. Urbanization economies, measured by service agglomeration and population density, are not significant either.

Finally, column 3 shows the results for transport equipment industry. This industry is sensitive to manufacturing agglomeration.

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<sup>9</sup> The results of the specification are the same, when estimations are run with R&D variable, which appear positive and significant, instead of manufacturing agglomeration variable, which is not surprising as correlation between manufacturing agglomeration and R&D activities is 0.9.

<sup>10</sup> When the specification is run with industrial wage, this variable appears not significant either.



Consequently, centripetal forces, or agglomeration forces, such as market (manufacturing agglomeration), linkages (location economies) and knowledge spillovers (R&D activities) are determinant location factors in chemical industry. In case of transport equipment industry manufacturing agglomeration is a determinant location factor too. Opposite to these, food and beverage industry only seems to be sensitive to centrifugal forces, such as fewer labor cost. Agglomeration economies are important location factors for chemical and transport equipment industries, but are not relevant, and even negative, for food and beverage industry.

#### **4- Concluding remarks**

Agglomeration factors have not often been included in studies of FDI location determinants. Most empirical studies that used data from the 60s, 70s and early 80s found that FDI then was mainly in greenfield form, and was resource -and market-oriented. However, during the last two decades FDI has been steadily changing: as it has oriented more and more towards strategic assets, such as intellectual capital, its location needs have changed too. For this strategic investment, whose objective 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 the new location places are also important. Thus, as Dunning (1998) suggests, while globalization separates geographically ownership and production location, agglomeration forces concentrate activity within particular regions and countries.

This study has attempted to analyse the location determinants of regional FDI, with special emphasis on new economic geography variables. Our analysis suggests that agglomeration economies are important determinants of regional FDI distribution. Manufacturing agglomeration, concentration of R&D activities and the availability of skilled labor are important determinants to manufacturing foreign direct investment, but congestion cost can act sometimes as a centrifugal force, rejecting foreign investment.

At industry level, empirical evidence supports that agglomeration economies, specially manufacturing agglomeration and location economies are significant attraction determinants to chemical and transport equipment industries. Concentration of R&D activities and skilled labor are also important to chemical industry. In food and

beverage industry empirical results are consistent with theories that stress the importance of costs, especially labor cost.

In the European Union, where national boundaries are becoming less important, regional factors should gain in importance as determinants of investment location. Consequently, more regional empirical research is needed in various directions. One direction is to study the role of regional incentives in location decisions, once information becomes available. Another direction is to deepen the possibility that location determinants vary across regions and industries, and go into detail of industry-specific variables on location choices. Finally, there is a need for further research into location preferences for plant investment.

## Appendix

Table 1: Description of explanatory variables

Variable	Definition	Expected Effect
Demand	Regional personal income 1993-2000, constant terms of 1995	+
Industrial Wage	Manufacturing wage per manufacturing wage earner, 1993-2000, constant terms of 1995	?
Food & Beverage Industry Wage	Wage in food & beverage industry per wage earner in the same industry, 1993-2000, constant terms of 1995	?
Chemical Industry Wage	Wage in chemical industry per wage earner in the same industry, 1993-2000, constant terms of 1995	?
Transport Equipment Industry Wage	Wage in transport equipment industry per wage earner in the same industry, 1993-2000, constant terms of 1995	?
Superior Education	Share of labor supply with superior education (university studies), 1993-2000	+
Secondary Education	Share of labor supply with secondary schooling, 1993-2000	+
Manufacturing Agglomeration	Manufacturing employment per square kilometer, 1993-2000	+
Food & Beverage Agglomeration	Share of regional industry wage earners in food and beverage sector	+
Chemical Agglomeration	Share of regional industry wage earners in chemical sector	+
Transport Equipment Agglomeration	Share of regional industry wage earners in transport equipment sector	+
Service Agglomeration	By share of total employment in tertiary sectors, 1993-2000	+
Population Density	Population per square kilometer, 1993-2000	?
R&D Activities	Share of firms' internal expenditure on R&D activities in regional GDP, 1993-2000, constant terms of 1995	+
Capital Effect & Information Costs	Dummy (1:Madrid, 0: Rest of regions) (1:Catalonia, 0: Rest of regions)	+ +

\*Sources:

- "Contabilidad Regional de España" (Regional Accounting of Spain) in Instituto Nacional Estadística (Statistics National Institute).
- "Renta Nacional de España y su Distribución" (National Income of Spain and its Distribution) in BBVA Foundation.
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Table 2

Regression Results for dependent variable: manufacturing FDI

	(1)	(2)	(3)	(4)
	GLS	GLS	GLS	OLS
Constant	-7.518 (-5.934)	-3.754 (-3.804)	-4.203 (-4.364)	-6.932 (-10.306)
Industrial Wage	2.195 <sup>b</sup> (2.180)	2.630 <sup>a</sup> (2.598)	2.452 <sup>a</sup> (2.357)	1.074 (1.282)
Superior Education		0.961 <sup>a</sup> (2.584)		
Manufacturing Agglomeration	1.514 <sup>a</sup> (3.383)			1.849 <sup>a</sup> (5.772)
Service Agglomeration	-0.967 (-0.561)	-2.830 (-1.639)	-1.329 (-0.768)	-1.315 (-0.966)
R&D Activities			0.391 <sup>b</sup> (2.068)	
Population Density	-1.267 <sup>a</sup> (-2.752)	1.148 (0.537)	-0.011 (-0.040)	-1.988 <sup>a</sup> (-5.317)
Madrid				1.461 <sup>a</sup> (5.168)
Catalonia				0.725 <sup>a</sup> (2.923)
R <sup>2</sup>	0.666	0.641	0.625	0.493
Adjusted R <sup>2</sup>	0.656	0.630	0.613	0.469
F- statistic				20.870
Hausman Test <sup>*</sup>	6.790			

Significance at <sup>a</sup>1%, <sup>b</sup>5%, <sup>c</sup>10%.

<sup>\*</sup>The fixed effect model is rejected in favor of a random effect model.

**Table 3**  
**Regression Results for Specific industries**  
**Generalised Least Squares (GLS)**

Industry	(1)	(2)	(3)
	Food & beverage	Chemical	Transport equipment
Constant	-10.902 (-2.931)	-8.332 (-1.475)	-16.924 (-2.795)
Industrial Wage	-5.399 <sup>c</sup> (-1.895)		
Specific industry wage		-1.368 (-0.575)	4.204 (1.024)
Secondary Education	-13.036 <sup>a</sup> (-2.783)		
Manufacturing Agglomeration	1.276 (0.877)	2.973 <sup>c</sup> (1.769)	3.104 <sup>c</sup> (1.725)
Specific Industry Agglomeration	-2.787 <sup>c</sup> (-1.667)	2.745 <sup>b</sup> (1.931)	1.228 (0.904)
Service Agglomeration	1.695 (0.367)	2.744 (0.449)	2.045 (0.294)
Population Density	-0.369 (-0.277)	-1.435 -0.866	-1.030 -0.540
R <sup>2</sup>	0.436	0.646	0.532
Adjusted R <sup>2</sup>	0.410	0.633	0.514
Hausman Test <sup>*</sup>	6.694	3.239	5.198

Significance at <sup>a</sup>1%, <sup>b</sup>5%, <sup>c</sup>10%.

<sup>\*</sup>The fixed effect model is rejected in favor of a random effect model.

Table 4  
Correlation Matrix of Independent Variables

	GDP	Manufac. Agglom.	Secondary Education	Service Agglom.	Population Density	R&D Activities	Industrial Wage	Superior Education
GDP	1.000000							
Manufac. Agglom.	0.967532	1.000000						
Secondary Education	0.853399	0.796122	1.000000					
Service Agglom.	0.545514	0.413523	0.783294	1.000000				
Population Density	-0.026059	-0.021856	-0.047390	0.123936	1.000000			
R&D Activities	0.950593	0.948518	0.738760	0.324627	-0.255727	1.000000		
Industrial Wage	-0.353888	-0.133694	-0.510643	-0.610079	0.004031	-0.218551	1.000000	
Superior Education	0.933101	0.922829	0.911368	0.551453	-0.279494	0.930914	-0.305075	1.000000

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