SPATIAL LINKAGES IN FDI LOCATION: EVIDENCE FROM THE SPANISH REGIONS

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ABSTRACT:

This paper examines the main factors behind the regional location of foreign direct investment (FDI) in Spain, at both the aggregate and sectoral levels, over the 1996-2013 period. To do so, a panel spatial Durbin model, which allows to unveil patterns of substitution or complementarity in FDI across regions, is estimated. Our findings reveal that inward FDI in one region is complementary to that in neighboring regions, a conclusion that is consistent with a complex vertical FDI strategy. Besides, they tend to confirm the hypotheses that FDI exhibits some inertia and is attracted by regions with (a) large market size, (b) large surrounding-market potential, and (c) high levels of human capital and wages. However, the results cast some doubts on the role played by infrastructure, R&D and regional differences in taxes as key elements in attracting FDI.

Key words: Foreign direct investment, FDI strategy, spatial econometrics, Spanish regions

JEL codes: C23; F21; F23

INTRODUCTION

The rapid increase in foreign direct investment (FDI henceforth) over the last few decades has fostered the interest in the study of its determinants in the economic literature, both at theoretical and empirical levels. This is mainly so because, from the point of view of the host economies, FDI is considered to be a key driver for economic growth. In particular, it is thought that FDI can benefit these economies not only through capital accumulation but above all through positive externalities related to technology transfers, know-how diffusion, productivity gains and increasing managerial skills.

Much of the previous research on the determinants of FDI, however, overlooks the potential presence of spatial dependence in the FDI distribution across host economies. To address this issue, recent theoretical contributions have incorporated the role of spatial linkages in the analysis of FDI determinants, thus unveiling the potential existence of motivations for FDI other than the 'pure' horizontal or vertical ones. As a result of this approach, multi-country models of both export platform (Yeaple, 2003; Bergstrand and Egger, 2004; Ekholm *et al.*, 2007) and complex vertical FDI (Baltagi *et al.*, 2007) have been developed.

It is because of this theoretical advancement, but also due to the existence of spatial econometric techniques proving that the exclusion of third-country (or third-region) effects in the analysis may lead to inefficient or inconsistent estimation of the parameters and then incorrect inferences (Anselin, 1988), that some recent empirical papers have addressed spatial issues in the study of FDI determinants. Among them, those by Baltagi *et al.* (2007), Blonigen *et al.* (2007), Garretsen and Peeters (2009), Poelhekke and van der Ploeg (2009), Villaverde and Maza (2015), and Regelink and Elhorst (2015) could be highlighted.

Bearing all these considerations in mind, the contributions of this paper to the literature stem from combining recent theoretical approaches with some methodological advances in spatial econometrics, along with a case study (the Spanish one at regional level) that has never been explored before in this context.[1] To the best of our knowledge, this is the first paper examining the strategy (motivation) and determinants of inward FDI to Spain within a spatial panel framework. It analyzes inward FDI to the Spanish regions over the period 1996-2013, splitting it into different sectors. The paper tries to provide answers to three basic questions: Which is the main strategy for inward FDI? What are its key determinants? Do FDI strategy and drivers differ across sectors?

More specifically, the contributions of this paper reside in four respects. First, the study specifies and estimates a panel spatial Durbin FDI model that offers some advantages over the conventional approach (namely, a spatial autoregressive model). Second, as regards the standardization of the spatial weight matrix, it uses the largest eigenvalue in order to sort out potential specification problems derived from the traditional row-normalization (Kelejian and Prucha, 2010; Elhorst, 2014). Third, and unlike previous papers (the only exception being that of Regelink and Elhorst, 2015), this study computes partial (both own- and cross-partial) derivative effects to obtain more accurate estimates of the impact of changes in each of the explanatory variables on FDI, and uses them, rather than point estimates, to unveil the main strategy for

FDI. Finally, it analyzes FDI determinants not only at an aggregate level but also at a sectoral one, this way avoiding the potential mask of heterogeneous patterns among sectors.

The remainder of the paper is organized as follows. The next section succinctly analyzes the theoretical and empirical background of spatial relationships in FDI. The third section presents the model specification and data, and states the hypotheses to be tested. The fourth section discusses the empirical findings, and the final section offers some concluding remarks and policy implications.

SPATIAL RELATIONSHIPS IN FDI

Theoretical background: A brief general discussion - FDI theory distinguishes between two-country (or bilateral) and multi-country general equilibrium models. As regards the bilateral framework, Markusen (1984, 2002), Helpman (1984) and Carr *et al.* (2001) are among the main contributors. Markusen (1984) proposes a general equilibrium model where multinational enterprises (MNEs), to reduce trade costs, are market-seeking oriented rather than export-oriented; accordingly, the FDI resulting from this process is known as horizontal FDI. Helpman (1984) develops a general equilibrium model where MNEs look for low factor costs in their production process, that is, he tries to explain vertical FDI. Finally, Carr *et al.* (2001) and Markusen (2002) integrate vertical and horizontal FDI strategies in the so-called *Knowledge-Capital Model*.

The bilateral framework of the aforementioned models overlooks the potential influence of spatial dependence in FDI decisions across host locations. Because of this, some of the stylized facts about FDI cannot be properly explained within this framework. Therefore, recent theoretical contributions have relaxed the two-country assumption to incorporate "third-country effects", this allowing to identify, apart from the pure horizontal or vertical FDI strategies, others such as export platform and complex vertical FDI. In this regard, Yeaple (2003), Bergstrand and Egger (2004), and Ekholm *et al.* (2007) develop multi-country models of export-platform FDI, in which a parent country invests in another to serve third markets with exports of final goods from the affiliate in the host country. In contrast, Baltagi *et al.* (2007) develop a multi-country model of complex vertical FDI, where MNEs set up their vertical chain of the production process across multiple countries to benefit from their comparative advantages;[2] this type of FDI is linked to exports of intermediate inputs from affiliates to third markets for the final processing.

Within this multiple-country context, we want to highlight the study of Blonigen *et al.* (2007) because our paper draws on this work. They propose a spatial lag model (equation 1) grounded on FDI theory to identify the different motives of MNEs to invest overseas. In this model, apart from the traditional host determinants, a spatially lagged FDI and a surrounding-market potential measure are also included as independent variables:

$$FDI_{it} = \beta_1 Host\ Variables_{it} + \beta_2 \sum_j W_{ij}\ GDP_{jt} + \rho \sum_j W_{ij}\ FDI_{jt} + \varepsilon_{it} \qquad (1)$$

where the surrounding-market potential ($\sum_j W_{ij}\ GDP_{jt}$) is a weighted average of the market size of all other host countries, and the spatial lag term ($\sum_j W_{ij}\ FDI_{jt}$) is a weighted average of the FDI received by the remaining countries other than *i,* which allows the data to reveal patterns of substitution or complementarity. MNE motivations can then be unveiled depending on the expected signs of the point estimates of the spatially lagged FDI (ρ) and the surrounding-market potential variable (β_2) coefficients (see Table 1).

INSERT TABLE 1 AROUND HERE

Pure horizontal FDI is based on the "proximity-concentration trade-off", according to which proximity to the host market reduces trade costs. When these costs between the home and host country are high, there is an incentive for horizontal or market-seeking FDI rather than for exporting. However, high setting up production costs may discourage this type of FDI. Since horizontal FDI is aimed at serving the local market of the host country, neighboring hosts' market size and FDI received by neighboring hosts are considered to be irrelevant. Hence, coefficients on both the spatial lag of FDI and the surrounding-market potential are expected to be not statistically different from zero.

In the case of the *export-platform FDI*, the MNE chooses the most preferred destination and considers it as a platform to export products to other markets. As the MNE will not build a production plant in each host destination, a negative sign for the spatially lagged FDI coefficient is expected (Blonigen *et al.*, 2007). On the contrary, the coefficient on the surrounding-market potential is expected to be positive since the MNE will locate its new plant in the host destination with best access to the largest surrounding market.

The third strategy, *pure vertical FDI*, is mainly driven by factor cost differences. The MNE locates its production in the host country with the lowest factor costs. Therefore, one might expect a negative spatial lag coefficient for vertical FDI since FDI in one country will be at the expense of FDI in neighboring countries. Additionally, the surrounding-market potential should not be relevant as the purpose of vertical FDI is to serve the home market, rather than foreign markets.

Finally, a more complicated variation of vertical FDI is the *complex vertical FDI.* In this case, the MNE sets up a vertical chain of production across various countries to take advantage of differences in factor prices and/or comparative advantages. Having suppliers in neighboring countries is likely to increase FDI to a particular market. Therefore, following Blonigen *et al.* (2007) a positive coefficient on the spatially lagged FDI is expected. One might also expect geographical clustering of such FDI flows for supply reasons. As regards the sign of the surrounding-market potential variable, it is expected to be insignificant for FDI with a complex vertical strategy. However, should we consider that larger surrounding markets might help to attract vertical suppliers and create agglomeration effects, the surrounding-market potential variable could also have a positive sign.

Empirical studies - There have also been recent empirical contributions taking into account the role of spatial linkages in FDI. In this subsection they are briefly reviewed, for which we distinguished between those with a national focus and those adopting a regional approach.

Within the framework described above, Blonigen *et al.* (2007) is the most relevant paper adopting a national perspective. It employs aggregate and sectoral data on US outward FDI to 35 host countries during the period 1983-1998 and finds evidence of significant spatial interactions. Although the estimates at aggregate level are quite sensitive to the sample considered (OECD, non-OECD and European OECD), when using sector-level FDI data, evidence of export-platform activity for most industries in the developed European countries is found. The same authors (Blonigen *et al.*, 2008), estimate a spatial lag model using FDI data from OECD countries into the US over the period 1980-2000, the results indicating the existence of an export-platform FDI strategy in the European subsample.

Estimating spatial lag and spatial error models for total as well as for industry and service FDI, Garretsen and Peeters (2009) analyze the presence of spatial linkages in Dutch FDI into 18 OECD host countries during the period 1984-2004. The combination of a positive spatial lag coefficient of FDI with a positive surrounding-market potential coefficient points to the existence of complex vertical FDI. However, when the area of study is limited to European countries, the coefficient of the spatial lag of FDI becomes negative and significant, which, together with the positive surrounding-market potential coefficient, suggests an export-platform FDI strategy. Poelhekke and van der Ploeg (2009), using a panel of US affiliates' sales in 76 foreign countries between 1984 and 1998, estimate spatial lag and spatial Durbin error models; the results indicate that horizontal and complex forms of FDI coexist. More recently, Nwaogu and Ryan (2014) estimate a spatial lag model and their results reveal the presence of spatial interdependence for US FDI into Africa, Latin America and the Caribbean over the period 1995-2007, and, in particular, that FDI has a complex vertical strategy with agglomeration. For their part, Regelink and Elhorst (2015), using US data on outward FDI into 20 European countries between 1999 and 2008, also estimate a spatial lag model and a spatial Durbin model; they find evidence in favor of competition among European countries in attracting US companies, and the results are consistent with the export-platform and pure vertical FDI motives.

Although Blonigen *et al.* (2007)'s approach is the most commonly used to determine the type of FDI strategy, it is also worth mentioning a different approach proposed by Baltagi *et al.* (2007) that has been employed at country level. They estimate, for the US outward FDI and a sample of 51 host countries and 11 manufacturing and non-manufacturing industries over the period 1989-1999, a multifaceted version of the aforementioned knowledge-capital model that, unlike Blonigen *et al.*, includes spatially weighted explanatory variables (and spatial autocorrelation in the error term). Then, they consider the signs of the estimated coefficients on the explanatory variables and their spatial lags to assess which FDI strategy (horizontal, export-platform, vertical or complex-vertical FDI) prevails. Their findings reveal significant third-country effects and evidence of vertical and complex vertical FDI. Similarly, Uttama and Peridy (2009) estimate Baltagi *et al.* (2007)'s model extended to include the effects of regional integration. Employing US outward FDI to five ASEAN countries (Singapore, Malaysia, Thailand, Indonesia and Philippines) over the period 1995-2007, the results show that third-country effects are relevant and that the main FDI strategies are vertical (or complex vertical) and export-platform.

There are also some papers which, following the Blonigen *et al.* (2007)'s approach, adopt a regional rather than a national perspective. In particular, Ledyaeva (2009) examines the determinants and spatial relationships of FDI inflows to Russian regions over the years 1995 to 2005, and finds that horizontal FDI strategies dominated in the period previous to the major financial crisis in Russia while the evidence for the post-crisis period is quite mixed between vertical and export-platform (recoined as *regional trade-platform* due to the scope of the paper) FDI strategies. With reference to the Chinese provinces, Sharma *et al.* (2014) estimate a spatial lag model and find evidence of strong spatial linkages during the period 1999-2007. Aggregate FDI tends to be trade-platform oriented, this indicating that neighboring provinces become competitors for FDI; in contrast, results based on industry-level provincial FDI show stronger support for vertical or complex vertical FDI.

Finally, there are some other papers that also take into consideration the presence of spatial effects as potential determinants of FDI at regional level, but which are not focused on ascertaining its motivation. The pioneering study in this vein is Coughlin and Segev (2000), in which a spatial error model is estimated; the results indicate that increased FDI in a Chinese province over the period 1990-1997 has significant positive effects on FDI in nearby provinces. Over the period 1995-2013 and for the Russian regions, Kayam *et al.* (2013) estimate a set of alternative spatial panel models (SAR, SEM, SDM and GSEM), the results indicating that FDI inflows do not generate agglomeration or substitution effects. Shocks to FDI levels in nearby regions have no effect on FDI inflows to hosts; however, FDI in a region depends on the market size and endowment of natural resources in alternative host regions. Blanc-Brude *et al.* (2014) use FDI inflows to Chinese prefecture-cities over the period 2004-2007 to estimate a number of spatial panel regression models (SEM, SAR, SEM-SAR and SEM-SAR allowing for serial correlation). The results indicate that the attractiveness of a particular location to foreign investors depends not only on the location-specific attributes but also on the proximity to alternative FDI locations. Using FDI into European NUTS-2 regions, Casi and Resmini (2014) estimate a spatial lag model over the period 2005-2007. Their results show that the capacity of a region to attract FDI depends on its location advantages as well as on the own country effect, further broken up into the within (the relative performance of the region within its own country) and the between country components (the relative performance of the country of which the region is part). To conclude, Villaverde and Maza (2015) also estimate a spatial lag model which indicates that positive spatial dependence is important in explaining inward FDI distribution among the European NUTS-2 regions during the period 2000-2006.

MODEL SPECIFICATION, DATA AND HYPOTHESES

Model specification and data - This section is devoted to assessing inward FDI main determinants.[3] As previously mentioned, a common practice in FDI literature consists in specifying a panel spatial autoregressive -or spatial lag- model (SAR), as in Blonigen *et al.* (2007). For the specific case of Spain, the SAR model of equation (1) trying to unveil FDI (as a percentage of GDP) determinants would be expressed as follows:

$$FDI_{it} = \beta_1 Host\ Variables_{it} + \beta_2 \sum_j W_{ij}\, GDP_{jt} + \rho \sum_j W_{ij}\, FDI_{jt} + \beta_3 FDI_{it-1} + \beta_4 d_{Madrid} + \beta_5 d_{chartered} + \varepsilon_{it} \quad (2)$$

There are some differences between equation (2) and equation (1). First, a dummy variable for Madrid (d_{Madrid}) is included due to the fact that figures regarding the regional distribution of FDI in Spain (available upon request) reveal that, for the whole sample period, Madrid has received nearly 65% of total FDI. Madrid's figure could be, therefore, somewhat oversized due to the headquarters effect, that is, because of the fact that FDI data collection in Spain is biased to the capital of the country, where most of the companies' headquarters are located. Second, a dummy variable for the chartered regions of Navarra and País Vasco ($d_{chartered}$) is added to the model since these regions have independent, more favorable tax systems, which might affect the FDI location process. Third, we also include the flows of inward gross FDI in region i lagged one period to capture potential inertia (FDI_{it-1}). Furthermore, time-specific fixed effects (μ_t) are incorporated to control for the specific characteristics of each year in explaining FDI inflows.[4]

As for the $Host\ Variables$, in line with the literature on FDI determinants and due to data availability reasons, the $Host\ Variables$ considered are market size (proxied by GDP), human capital (HC), wages ($WAGE$), infrastructure (I) and research and development ($R\&D$). It should be mentioned that wages and human capital are included as an interaction variable ($WAGE * HC$) because, although their components could be incorporated separately, we found out in a preliminary estimation that wages were picking up the effect of human capital on FDI; to avoid this, we opted for including the multiplicative variable. All explanatory variables, but the dummy, are measured in logs.

Although the model in equation (2) accounts for spatial dependence in FDI, it does not consider the effect of the interaction of the host variables among neighboring regions (apart from the market size); in other words, it does not take into account that an improvement in e.g. infrastructure in neighboring regions can affect FDI flows toward any region *i*. Consequently, to solve this issue, this paper specifies a panel spatial Durbin model (SDM), which extends equation (2) by including not only the surrounding-market potential indicator but also all the spatially lagged explanatory variables. It is important to note that the Likelihood Ratio (LR) tests, reported in Table 2, indicate that the SDM cannot be simplified into a SAR or into a Spatial Error Model (SEM); this result is in support of our approach.[5] A further advantage of the SDM is that the omitted variable bias is reduced.

INSERT TABLE 2 AROUND HERE

Therefore, the paper proposes a SDM as the best way of dealing with the FDI strategy and determinants issues, and this decision is reinforced by both theory and empirical (econometric) evidence. Hence, the specification of our final FDI model, once the host variables are explicitly included in it, is as follows:

$$FDI_{it} = \beta_1 GDP_{it} + \beta_2 (WAGE * HC)_{it} + \beta_3 I_{it} + \beta_4 R\&D_{it} + \theta_1 \sum_j W_{ij}\, GDP_{jt} + \theta_2 \sum_j W_{ij}\, (WAGE * HC)_{jt} + \theta_3 \sum_j W_{ij}\, I_{jt} + \theta_4 \sum_j W_{ij}\, R\&D_{jt} + \rho \sum_j W_{ij}\, FDI_{jt} + \beta_5 FDI_{it-1} + \beta_6 d_{Madrid} + \beta_7 d_{chartered} + \mu_t + \varepsilon_{it} \quad (3)$$

Once the benchmark model has been specified, some comments seem to be pertinent regarding the spatial weight matrix (W), which we take as the inverse distance matrix.[6] Although it is common practice in spatial econometrics to row-normalize it, so that each row sums to unity, Kelejian and Prucha (2010) demonstrate that normalization of its elements by a different factor for each row as opposed to a single factor is likely to lead to misspecification problems.[7] For this reason and following Regelink and Elhorst (2015), we compute an inverse distance matrix normalized by its largest eigenvalue.

In addition, a relevant aspect concerning the interpretation of the estimated coefficients should be clarified. The estimates of equation (3) must be taken as a preliminary step to subsequently compute the summary measures of direct, indirect, and total effects, since the standard regression interpretation of coefficient estimates as partial derivatives no longer holds (LeSage and Pace, 2009). This is due to the fact that the data generating process of the above model represents a non-linear relationship between the dependent variable and the explanatory variables due to the presence of the inverse matrix $(I_n - \rho W)^{-1}$, the so-called spatial multiplier effect. As this inverse matrix can, in turn, be expressed as an infinite series expansion ($(I_n - \rho W)^{-1} = I_n + \rho W + \rho^2 W^2 + \rho^3 W^3 + \cdots$), feedback effects, arising as a result of impacts passing through neighboring regions and coming back to the region where the change originated from, are considered in the model (Halleck Vega and Elhorst, 2015). In consequence, marginal effects or partial derivatives measuring the impact of changes in each of the explanatory variables on the dependent variable should be employed rather than point estimates; in other words, summary measures of direct, indirect and total effects have to be calculated (LeSage and Pace, 2009). The matrix of partial derivatives of the expected value of FDI with respect to the *k*th explanatory variable takes the following form: $(I_n - \rho W)^{-1}[I\beta_k + W\theta_k]$, so that the average direct effect is computed by averaging the own-partial derivatives (the main-diagonal elements of the matrix of effect estimates of each explanatory variable). Therefore, the direct effect measures the average impact on the FDI received in a specific region caused by a one-unit change in any explanatory variable of that region. On the other hand, the average indirect or spillover effect is computed by the average row sum of the cross-partial derivatives (the off-diagonal elements) of each region, and measures the average change on the FDI received in a particular region caused by a change of one unit in any explanatory variable of neighboring regions. The total effect is the sum of the direct and indirect effects.[8]

Finally, and before presenting the hypotheses to be tested, some information regarding data has to be provided. Table 3 includes the definitions, units of measurement, and data sources of all variables. Summary statistics of both the raw and spatially lagged variables are provided in Table 4.

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Hypotheses - At this point we first formulate the hypotheses to determine the FDI strategy, which is the main aim of the paper. Regarding the framework of complementarity and substitution in FDI previously outlined (Blonigen *et al.*, 2007), and due to the fact that Spanish regions are small geographical units and not too distant from each other, a pattern of complementarity (positive agglomeration effects) in FDI is likely to arise. In the terminology of Brainard (1997), concentration outweighs proximity. Neighboring regions are likely to complement each other, which means that substantial FDI in regions other than *i* may foster FDI to region *i*. Therefore, our first hypothesis is that there are positive spatial linkages in FDI. Considering the surrounding-market potential variable ($\sum W\,GDP$), it should be mentioned that FDI is supposed to be positively linked to the perspective of a sales expansion in the host region if this is surrounded by regions with high market potential (Head and Mayer, 2004). Therefore, our second hypothesis is that large surrounding-market potential positively influences FDI attraction. Combining both hypotheses, it can be postulated that FDI flows in Spain follow a complex vertical strategy which looks for geographical clustering of such FDI flows for supply reasons and a large surrounding-market.

With respect to the host variables, market size (GDP) represents potential market demand. According to theory, regions having high income are likely to receive more FDI since higher GDP is associated with greater demand for goods and services (Dunning, 1980; 1988). As this makes the host region more attractive for FDI, it leads to the third hypothesis that a large market size positively influences the attraction of FDI inflows.

Local labor market conditions also impinge upon inward FDI. Labor costs ($WAGE$) have traditionally been considered as affecting the decision of where to invest. So, initially, it seems that the relationship between labor costs and FDI might be negative, provided that it does not imply lower levels of productivity (Dunning, 1998). Empirical evidence for Spain, however, cannot confirm that lower labor costs had played a pivotal role in attracting FDI (Díaz-Vázquez, 2003). Human capital (HC) could also affect investors' decisions since a better education and training means more productivity (Dunning, 1980). Therefore, high labor costs may be the outcome of high human capital endowments and, as previously mentioned, for Spain it seems to be the case. Accordingly, we decided to include both variables in an interactive way ($WAGE * HC$)[9] under the assumption that the higher the value of this composite variable, the higher the level of FDI. Hence our fourth hypothesis states that regions with high levels of human capital and, therefore, high wages receive more FDI flows.

Besides, transport infrastructure endowment (I) is considered an important factor when deciding the location of FDI. Well-developed infrastructure facilitates transport and communication, which can in turn increase the productivity of investment and stimulate inward FDI flows. On the contrary, an inadequate infrastructure endowment could hinder the location of FDI in a particular area. Thus, the fifth hypothesis is that good transport infrastructure fosters FDI attraction.

Moreover, research and development expenditure ($R\&D$) could enhance FDI location if firms seek to strengthen their technological advantages and locate part of their R&D activities abroad. High levels of R&D expenditure may draw in strategic asset-seeking FDI. So, following Fallon and Cook (2010), regional expenditure on R&D is taken as a proxy for strategic asset seeking FDI-related variable. The sixth hypothesis is that R&D expenditure promotes FDI attraction.

As FDI is a long-term capital investment, it is likely to agglomerate and, therefore, self-reinforce, an idea that is captured by the time lag of FDI (FDI_{it-1}). Thus, the seventh hypothesis is that there is some inertia in FDI.

As mentioned before, FDI is highly concentrated in Madrid; a possible explanation for this fact could lie on the so-called headquarters effect. Accordingly, the dummy variable for Madrid (d_{Madrid}) tries to capture such headquarters effect;[10] in other words, the fact that FDI data collection in Spain is biased to the capital region as it is the headquarters of multinational companies. Thus, our eighth hypothesis is the existence of a headquarters effect.

Finally, the dummy variable for the chartered regions of Navarra and País Vasco ($d_{chartered}$) tries to pick up the fact that these regions have independent tax systems. Thus, our ninth and last hypothesis is that these independent tax systems, leading to more favorable corporate tax treatment, foster FDI location.

EMPIRICAL RESULTS

Our model, as specified in equation (3), is estimated by maximum likelihood[11] at both aggregate and sectoral (industry and services) levels;[12] by splitting FDI at sectoral level we try to figure out the differences between sectors when it comes to attracting FDI flows. Only for the sake of completeness and to confirm, as said before, the need of including spatial effects in the model, we also run an OLS estimation without them, so that the reader can see the strong difference existing between the estimates from our spatial approach vis-à-vis non-spatial approaches. Anyway, several really simple but quite illustrative examples of how a spatial regression model can be used to quantify spatial spillovers, as well as their relevance, can be found in LeSage and Pace (2009).

Table 5 presents the results of the OLS without spatial effects model (first column) and the SDM (remaining columns) using aggregate regional data. The results drawn for unobserved time-specific effects are not included for reasons of space; notwithstanding, it is important to say that these effects are jointly significant, which indicates that the model accounts for temporal specific characteristics affecting the dependent variable; this mitigates the potential omitted-variable bias. As for the SDM, the second column of the table reports the point estimates whereas the rest of columns report the direct, indirect and total effect estimates. Firstly, it is important to stress that there are remarkable differences between the non-spatial approach and the spatial one. The most noticeable one refers to the GDP variable. As can be seen, it seems to be non-significant according to standard estimates, whereas when spatial effects are included in the model it becomes one of the main drivers of FDI. Needless to say, it is instrumental not to overlook the presence of third-region effects in the analysis.

The spatial lag term of FDI is positive and statistically significant, which indicates that there exist positive spatial linkages across Spanish regions with reference to inward FDI, namely, that FDI in one host region complements FDI in nearby regions (hypothesis 1); this finding is in line with Garretsen and Peeters (2009) and Villaverde and Maza (2015).

Regarding the surrounding-market potential variable, the positive and statistically significant indirect effect associated to market size indicates that the larger it is the more attractive the region becomes (hypothesis 2). This result, that is in line with Garretsen and Peeters (2009) and Regelink and Elhorst (2015), can be seen as a positive direct effect of the surrounding-market potential variable; this reinforces the fact that the market size of neighboring regions is an important driver for FDI, that is, reinforces the presence of agglomeration effects. It is worth mentioning the existence of a significant difference between the point estimate (0.97) and the direct effect (2.99) of the surrounding-market potential, which indicates that feedback effects arising because of impacts passing through neighboring regions and back to the region itself are very important.

Consequently, the positive spatial lag of FDI along with the positive indirect effect of GDP is consistent with a complex vertical strategy for FDI with agglomeration. Therefore, it seems that MNEs slice up the value chain of their production process by seeking out suppliers in closer regions.

Delving into the impact of the market size (GDP) variable, its total effect is positive and statistically significant, indicating that host regions' market size is an important determinant for FDI attraction; this result is very common in the empirical literature. It should be highlighted that, although both direct and indirect effects are positive (supporting hypothesis 3), the indirect effect is the predominant one; this means that FDI is attracted by regions that, apart from having a large own market size, are surrounded by regions with large market size too.

As for the interaction variable, its total effect is positive and statistically significant, which is in line with the results obtained by Bajo-Rubio (1991), Bajo-Rubio and López-Pueyo (1996) and Martín and Velázquez (1996) for Spain as a country. If we take a look at the breakdown of this total effect, it can be noticed that the direct effect is positive and statistically significant, which indicates that FDI is attracted by regions with high levels of human capital that, accordingly, pay high wages (hypothesis 4). This result agrees with Blonigen *et al.* (2007), in which FDI is attracted to high-skill, high-wage locations within the OECD.

Furthermore, considering infrastructure endowment, the direct, indirect and total effects are not statistically significant; therefore, hypothesis 5 is not supported. In addition, R&D expenditure does not seem to influence the FDI location process. Hence, hypothesis 6 is not supported either, revealing that FDI is not looking for strategic assets in the Spanish regions.

Moreover, the time lag of FDI is positive and statistically significant, this supporting the presence of inertia in FDI flows (hypothesis 7). As regards the dummy for Madrid, its positive and statistically significant coefficient clearly supports the existence of a headquarters effect (hypothesis 8). Considering the dummy variable for the chartered regions of Navarra and País Vasco, our findings convey an important message: differences in the tax system are not instrumental when it comes to attracting FDI to the Spanish regions (hypothesis 9).

All in all, our findings allow us to say something about the reasons why firms from foreign countries invest into the Spanish regions. These findings seem to point out that foreign firms mainly invest in Spain for reasons of sales, headquarters, and production, while they are not driven by R&D or regional differences in taxes.

INSERT TABLE 5 AROUND HERE

Having drawn some important results at the aggregate level, next we want to know whether the FDI strategy and the spatial dependence among regions differ or not across sectors.[13] For this reason, we extend our study by replicating it for the industry and service sectors, as they concentrate the bulk of FDI (more than 95% of total FDI in Spain). In addition, it is important to note that the distribution of FDI by sectors differs notably across regions. While in some regions (such as Asturias, Extremadura, and Murcia) the FDI received by the industry sector has been of paramount importance, in others (namely Baleares, Madrid, and Castilla y León) it is the service sector the one that concentrates most of the FDI received.

Table 6 displays the results. Considering the industry sector, it should be noted that there are some differences with respect to the aggregate analysis. Specifically, the direct and indirect effects of GDP become statistically non-significant, so the second and third hypotheses are not supported in the industry sector. As regards MNE strategies, FDI exhibits, in line with the aggregate analysis, a dominant complex vertical strategy in the industry sector.[14]

As for services, the results are quite similar to those obtained by using aggregate FDI. The only remarkable difference is that spillovers associated to the interaction variable of wages and human capital arise, this indicating that the higher the human capital and wages of regions other than *i*, the less FDI in the service sector will enter region *i*. These spillovers are, in fact, much more intense than the direct effect. While FDI coming to the service sector is as well mainly complex vertical, it can be appreciated (through the comparison of the coefficient on the spatial lag of FDI in both sectors) that it is more sensitive to that received by surrounding regions than in the industry sector.

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SUMMARY AND CONCLUSIONS

The study of the strategy and determinants of inward FDI flows at regional level is of great interest to academic researchers and policymakers alike. Traditionally this study has been done without paying much attention to the role of spatial dependence across FDI-hosting regions, which leaves aside the possibility of unveiling the true motivations and determinants of FDI. This paper addresses this issue for the Spanish regions over the period 1996-2013, by explicitly considering the role and presence of spatial spillovers. It adds to previous papers in four respects: firstly, in that spatial interactions are included in all variables; secondly, in that the normalization of the distance matrix is more reliable than in most papers as it avoids interpretation problems; thirdly, in that it does not use point estimates when it comes to defining FDI strategies, which could lead to misleading conclusions, and, finally, in that it develops the analysis at both aggregate and sectoral levels.

After a revision of the theoretical and empirical (spatial approach) literature on FDI strategies and its determinants carried out in the second section, we present the model specification (panel spatial Durbin model) and data, and discuss the empirical results. The analysis clearly shows that FDI comes to Spanish regions for reasons of headquarters, sales and production but not for reasons related to R&D or regional differences in taxes. Specifically, aggregate FDI inflows in Spain present some inertia and are mainly determined by the market size, the surrounding-market potential, and the level of human capital in interaction with wages.[15] The positive and statistically significant spatial lag of FDI also reveals the existence of strong spatial linkages across Spanish regions, namely that FDI in one host region complements FDI in nearby regions; this finding is consistent with a complex vertical FDI strategy.[16] Furthermore, the positive and significant indirect effect of the GDP reveals the existence of agglomeration effects. Finally, the regressions for FDI in the industry and service sectors support a dominant complex vertical FDI strategy in Spain, where MNEs look for regional clustering of FDI flows for supply reasons.

To conclude, we believe some quite remarkable policy implications can be drawn from our analysis. Due to complementarity of FDI across regions, policymakers could and should design joint schemes at regional level to attract FDI to Spain and better exploit potential synergies among regions. Needless to say, these joint plans would be especially rewarding for the existing regional clusters, made up of key regions with large inflows of FDI (mainly Madrid due to the headquarters effect, and to a lesser extent regions such as Cataluña, País Vasco, and Comunidad Valenciana) and the surrounding ones. But it is also obvious that these plans become instrumental for the remaining regions, let's say the peripheral ones, as their geographical location does not allow them to easily benefit from FDI received by others. Since our findings point to a complex-vertical FDI strategy, the only chance for these regions seems to be to build up strong linkages (or to foster the existing ones) with suppliers located in other regions. To do so, regional embedding policies focused, for example, on the identification of potential local suppliers and/or on local supplier development programs would be welcome, especially if they are integrated with wider regional development initiatives. Otherwise, these regions are going to lag even further behind and lose in the FDI race.

Another important conclusion we can gain from this paper is that, to maximize their chances of attracting FDI, regions should fearlessly pursue policies aimed at improving the quality of their workforce, since their potential negative side effect (increase in wages) is not strong enough to lessen FDI. Finally, it does not seem that regional differences in profit and capital gains taxes affect FDI, so this type of policies would not be desirable.

Even accepting that the results obtained in a study of this nature can depend critically on both place and time, it is still possible to draw some lessons for other countries/case-studies that, notwithstanding, should be taken with due caution. From a methodological point of view the lesson is, anyway, quite straightforward: the presence of spatial effects cannot be overlooked when examining FDI determinants at regional level. Otherwise, the findings will probably be biased and misleading. From a policy perspective, however, only tentative lessons can be drawn from the Spanish experience. On the one hand, provided that the prevailing FDI strategy is the same as in our case-study and therefore there exists complementary of FDI, the recommendation of designing joint strategies at regional level could also be accepted for other countries. In addition, as the presence of agglomeration is a feature of FDI not only in Spain but also in most countries (Jones, 2017), it is obvious that the attractiveness degree of regions depends on their geographical location and that our conclusion stating that some regions should strive more than others to entice FDI holds. The type of effort described here is not, however, applicable to every country; it should be qualified depending on the FDI strategy that predominates. Furthermore, we believe our results regarding taxes tend to convey the message that the theoretical literature on FDI and tax incentives can be applied only at the country level (or when comparing regions of different countries); that is to say, differences in taxes across regions belonging to the same country do not seem to be, by and large, high enough to play a significant role when boosting FDI. On the contrary, we do not consider the conclusion regarding the improvement of the quality of the workforce can be taken on faith for other case-studies, as it crucially depends on the level of development of the country and the FDI strategy.

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Table 1. *FDI strategies and hypothesized signs of the spatial lag and surrounding-market potential coefficients.*

FDI strategies	Sign of spatial lag	Sign of surrounding-market potential
Pure horizontal	0	0
Export platform	−	+
Pure vertical	−	0
Complex vertical	+	0/+

Source: Blonigen *et al.* (2007).

Table 2. *LR tests for spatial dependence.*

Tests	Statistic	*p*-value
LR test for Spatial Autoregressive Model	22.66	0.00
LR test for Spatial Error Model	10.21	0.00

Source: Own elaboration.

Table 3. *Variables, measures and data sources.*

Variable	Definition	Units	Data source
FDI	Flows of inward gross FDI as percentage of GDP	%	Spanish Foreign Investment Registry (DataInvex) and Spanish National Statistical Institute (INE)
GDP	Ln(Gross domestic product)	Billion euros of 2000	Spanish National Statistical Institute (INE)
$WAGE * HC$	Ln(Interaction variable between monthly remuneration per employee ($WAGE$) and human capital (HC))	$WAGE$: Thousand euros of 2000 HC: Education index [a] computed with data of employed population by educational attainment	Cambridge Econometrics Valencian Institute of Economic Research (IVIE)
I	Ln(Road infrastructure)	Kilometers of motorways per 1000 km^2	Eurostat
$R\&D$	Ln(R&D expenditure)	Million euros	Eurostat

Note: [a] The education index is defined as $HC = \sum_{i=1}^{7} \varphi_i A_i$ where φ_i indicates the weight associated with each level of human capital *i* over the total employed population and A takes the values 0, 6, 10, 12, 14, 15 and 17 for *i* = 1, 2, 3, 4, 5, 6 and 7. The levels of human capital are as follows: *i* = 1 = illiterate, *i* = 2 = without studies and primary education, *i* = 3 = compulsory secondary education, *i* = 4 = high school and middle-level training program, *i* = 5 = higher level training program, *i* = 6 = previous to superior and *i* = 7 = superior studies.

Source: Own elaboration.

Table 4. *Descriptive Statistics*.

Variable	Mean	CV	Min.	Max.
FDI_{it}	0.89	2.04	0.01	17.17
GDP_{it}	3.32	0.28	1.40	5.04
$(WAGE * HC)_{it}$	2.75	0.08	2.25	3.30
I_{it}	3.24	0.19	1.79	4.58
$R\&D_{it}$	5.52	0.23	2.63	8.27
$\sum_j W_{ij} FDI_{jt}$	0.85	0.58	0.08	3.53
$\sum_j W_{ij} GDP_{jt}$	2.93	0.31	0.56	4.77
$\sum_j W_{ij} (WAGE * HC)_{jt}$	2.49	0.33	0.47	4.24
$\sum_j W_{ij} I_{jt}$	2.95	0.34	0.51	4.99
$\sum_j W_{ij} R\&D_{jt}$	4.97	0.33	0.87	8.62

Note: CV: Coefficient of Variation.

Sources: Spanish Foreign Investment Registry, INE, Cambridge Econometrics, IVIE, Eurostat and own elaboration.

Table 5. *Aggregate FDI Regression.*

Variables	OLS without spatial effects	SDM coefficient	Direct Effect	Indirect Effect	Total Effect
GDP_{it}	0.22	0.26***	0.45***	2.99***	3.44***
	(0.23)	(0.09)	(0.20)	(1.10)	(1.27)
$(WAGE * HC)_{it}$	3.22***	4.35***	5.75***	13.99	19.75***
	(0.65)	(0.69)	(1.51)	(16.55)	(7.05)
I_{it}	0.14	-0.14	-0.81	-13.40	-14.21
	(0.14)	(0.16)	(0.94)	(12.76)	(13.69)
$R\&D_{it}$	-0.07	-0.12	0.01	3.08	3.09
	(0.19)	(0.20)	(0.35)	(3.49)	(3.77)
d_{Madrid}	9.87***	9.42***			
	(0.53)	(0.54)			
$d_{chartered}$	-0.84***	-0.45			
	(0.24)	(0.31)			
FDI_{it-1}	0.19***	0.14***			
	(0.03)	(0.03)			
$\sum_j W_{ij} GDP_{jt}$		0.97***			
		(0.34)			
$\sum_j W_{ij} (WAGE * HC)_{jt}$		2.60			
		(1.71)			
$\sum_j W_{ij} I_{jt}$		-4.99***			
		(1.53)			
$\sum_j W_{ij} R\&D_{jt}$		1.24*			
		(0.71)			
$\sum_j W_{ij} FDI_{jt}$		0.53**			
		(0.23)			
Observations	306	306			
Log-likelihood	-412.58	-394.28			

Notes: Standard errors in parentheses: *** Significant at 1%; ** Significant at 5%; * Significant at 10%. Time fixed-effects are included in all estimations. SDM results obtained using the inverse distance matrix.

Sources: Spanish Foreign Investment Registry, INE, Cambridge Econometrics, IVIE, Eurostat and own elaboration.

Table 6. *Sector-level FDI Regressions*.

Variables	Industry					Services				
	OLS without spatial effects	SDM coefficient	Direct Effect	Indirect Effect	Total Effect	OLS without spatial effects	SDM coefficient	Direct Effect	Indirect Effect	Total Effect
GDP_{it}	-0.06	-4.22	-3.01	26.37	23.36	0.12	0.27***	0.26***	2.56***	2.82***
	(2.75)	(3.06)	(5.44)	(68.54)	(72.82)	(0.36)	(0.09)	(0.08)	(0.89)	(1.04)
$(WAGE * HC)_{it}$	20.99***	21.25***	26.00**	2.88	28.88	3.07***	2.62**	3.98**	-10.08*	-6.10
	(7.49)	(7.42)	(10.12)	(128.21)	(134.80)	(1.03)	(1.06)	(1.71)	(6.08)	(6.05)
I_{it}	1.21	2.13	-3.56	-76.84	-80.41	-0.12	-0.43*	-0.04	7.59	7.55
	(1.70)	(1.97)	(13.07)	(187.42)	(200.38)	(0.22)	(0.26)	(0.50)	(6.03)	(6.35)
$R\&D_{it}$	0.57	3.54	0.00	-53.62	-53.61	0.01	-0.00	-0.19	-1.85	-2.04
	(2.27)	(2.36)	(7.70)	(102.66)	(109.89)	(0.30)	(0.31)	(0.54)	(2.29)	(2.33)
d_{Madrid}	31.21***	29.85***				11.71***	11.10***			
	(6.36)	(6.48)				(0.83)	(0.85)			
$d_{chartered}$	-7.71***	-6.73				-0.75*	0.08			
	(2.84)	(4.80)				(0.39)	(0.49)			
FDI_{it-1}	0.16***	0.17***				0.49***	0.47***			
	(0.05)	(0.05)				(0.03)	(0.03)			
$\sum_j W_{ij}\, GDP_{jt}$		0.29					0.97***			
		(9.42)					(0.34)			
$\sum_j W_{ij}\, (WAGE * HC)_{jt}$		-25.51					0.95			
		(18.12)					(2.40)			
$\sum_j W_{ij}\, I_{jt}$		11.11					-3.63			
		(17.73)					(2.37)			
$\sum_j W_{ij}\, R\&D_{jt}$		5.33					1.08			
		(8.23)					(1.10)			
$\sum_j W_{ij}\, FDI_{jt}$		0.82***					0.87***			
		(0.30)					(0.31)			
Observations	306	306				306	306			
Log-likelihood	-1168.59	-1154.95				-550.75	-536.15			

Notes: Standard errors in parentheses: *** Significant at 1%; ** Significant at 5%; * Significant at 10%. Time fixed-effects are included in all estimations. Results obtained using the inverse distance matrix. *Sources*: Spanish Foreign Investment Registry, INE, Cambridge Econometrics, IVIE, Eurostat and own elaboration.

[1] As far as we know, there are only five empirical studies on the determinants of FDI inflows in Spain using regional data, but none of them deal with FDI strategies by considering spatial effects (Pelegrín, 2002; Pelegrín and Bolancé; 2008; Rodríguez and Pallas, 2008; Villaverde and Maza, 2012; Gutiérrez-Portilla *et al.*, 2016).

[2] According to UNCTAD (2002) "to take advantage of fine differences in costs, resources, logistics and markets".

[3] Unfortunately, there is no means to distinguish between greenfield and mergers and acquisitions flows. The main advantage of our database (DataInvex, as indicated in Table 3) lies on the fact that it provides data, at regional level, of productive FDI, but we have to acknowledge it does not differentiate between greenfield FDI projects and mergers or acquisitions. As said, the use of this data source allows us to take only productive FDI into account, so that investment corresponding to foreign stock holding companies, which sole aim is to reduce the tax bill, is not included. This is quite important, as these practices have created large geographical and sectoral composition biases in inward FDI data.

[4] As for this respect, following the suggestion made by a reviewer we tested for the existence of remarkable differences between non-crisis and crisis subperiods. The results were quite similar and are available upon request.

[5] The likelihood-ratio criterion also supports our model specification (the results are better for the SDM than for the SAR).

[6] We follow the Bayesian model comparison approach and calculate the log-marginal likelihood and the posterior model probabilities to choose between different spatial weight matrices (the inverse distance matrix, the inverse square distance matrix, the exponential distance matrix, the 3, 4 and 5 nearest neighbor spatial weight matrices and several matrices with cut-off points) (LeSage, 2015). The spatial weight matrix with higher posterior model probability is the inverse distance matrix.

[7] Anselin (1988) and Elhorst (2014) argue that row-normalizing an inverse distance matrix might lead to a loss of the economic interpretation in terms of distance decay.

[8] Researchers are usually interested in knowing these summary measures, firstly proposed by Pace and LeSage (2006). Anyway, if you are interested in knowing to what extent the impact of changes in explanatory variables differs over all regions, you can pay attention to each component of the partial derivatives matrix, as in Gutiérrez-Portilla *et al.* (2018).

[9] This is not unusual in the FDI literature, as can be seen, for example, in Bajo-Rubio *et al.* (2010).

[10] Although Madrid receives more FDI than the rest of regions during the whole period, these flows are highly volatile and in some specific years they are much higher. In an attempt to capture it, the dummy for Madrid is defined taking a value of 1 for these specific years: 2000, 2007, 2008 and 2011 for aggregate FDI; 2001, 2002, 2007, 2008, 2009 and 2012 for industry FDI; and 1999, 2000, 2001, 2002, 2008 and 2011 for service FDI.

[11] Maximum likelihood estimation requires the assumption of normal error terms. The result obtained from the Shapiro-Wilk test supports it.

[12] For a similar approach on greenfield investments in the EU neighborhood see Ascani *et al.* (2017).

[13] A paper revealing that this is happening for the UK regions is Fallon and Cook (2014).

[14] Regarding the industry sector, we have performed the same estimations disaggregating FDI by technology intensity. The results confirm that low, middle and high-technology industries are characterized by complex vertical FDI as well.

[15] Here it is important to note that, following the suggestion made by a referee, we tested vis-à-vis causality between the variables included in the model and FDI. To do so, we computed the bivariate generalization of the Moran's I statistic as this is the only test that can be used given the size of our sample. Indeed, the only novel approach we are aware of to address causality in a spatial framework (Herrera et al., 2016) is very data-demanding and, therefore, not applicable to our case. Concerning the findings, for the specific case of the interaction variable they indicate there is a positive bidirectional link between human capital (in interaction with wages) and FDI. In other words, there seems to be not only a cause-effect relationship between the interaction variable and FDI but also a feedback one, which to a certain extent reinforces its role in the FDI location process.

[16] A similar result is found by Garretsen and Peeters (2009) for Dutch outward FDI into OECD countries, Uttama and Peridy (2009) for US outward FDI into ASEAN countries, Nwaogu and Ryan (2014) for US outward FDI into Africa, Latin America and the Caribbean, and Sharma *et al.* (2014) for industry level FDI into Chinese provinces.