On the Drivers of UK Direct Investment in the Spanish Regions: A Spatial Durbin Approach

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ABSTRACT

This paper empirically examines the key factors driving UK direct investment in the Spanish regions over the period 2000-16 and, consequently, tries to unveil its main motivation. Applying a spatial Durbin panel model to capture spatial linkages, the results point to the existence of complementarity between the FDI received by a region and that of the remaining ones. This outcome, along with a positive and statistically significant spillover effect of market potential, reveals that complex-vertical FDI motivation with agglomeration economies prevails among UK MNEs investing in Spain. Additionally, our findings unveil the role played by some other FDI drivers, such as wages and infrastructure. Furthermore, the paper is unique in decomposing the average direct and spillover effects by region and pairs of regions, so that remarkable differences can be identified. This breakdown has strong significance from a policy perspective since it can guide regional policymakers. In short, our findings point out to the fact that FDI policy should be jointly designed by those regions presenting strong bilateral spillover effects. Thus, greater cooperation among policymakers would be welcome.

KEYWORDS**:** UK direct investment; FDI motivation; spatial Durbin model.

JEL CODES**:** C23; F21; F23.

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1. Introduction

Foreign direct investment (FDI henceforth) flows have grown noticeably over the last few decades everywhere, and the analysis of the factors affecting them has become the subject of renewed policy and academic interest. This is so not only because of their rapid increase but also because FDI is considered a relevant factor in boosting economic growth (for a survey, see Iamsiraroj & Ulubaşoğlu, 2015, while for the latest contribution, see Zhao, Wong, Wong & Jiang, 2020). FDI can benefit host locations in different ways but mainly through technology transfer, employment and export promotion, capital accumulation and human capital improvement (e.g. De Mello, 1997). However, despite the vast and continually growing literature on the complex topic of FDI location, it must be acknowledged that we know very little about the role played by spatial interactions across recipients, as well as how they can affect FDI flows.

This is the reason why some advances in this field have been recently made on both theoretical and empirical grounds. Modern theoretical developments depart from the standard two-country framework (for a thorough review of this type of models, see Antras & Yeaple, 2014) to emphasise not exclusively the characteristics of the host countries but also those of their neighbours. Therefore, these new models deal with the presence of spatial spillovers, the so-called third-country effects.[1] In the same vein, the New Economic Geography literature (Fujita, Krugman & Venables, 1999; Egger, Gruber, Larch & Pfaffermayr, 2007) highlights the importance of agglomeration effects when trying to explain FDI decisions. Put differently, this literature stresses the fact that a multinational enterprise's (MNE) choice to invest or not to invest overseas can be affected by those of other MNEs. Consequently, new FDI motivations, apart from the well-known 'pure' horizontal or vertical ones, have arisen. In this respect, Yeaple (2003), Bergstrand and Egger (2004), Ekholm, Forslid and Markusen (2007), Ito (2013), and Oyamada (2019) develop models of export-platform FDI, where a (parent) firm chooses to produce in one host country to serve third markets. Similarly, Baltagi, Egger and Pfaffermayr (2007), and Hayakawa and Matsuura (2011) propose a model of complex-vertical FDI, in which MNEs set up a chain of production across multiple locations to exploit their comparative advantages. This shift of attention towards more intricate integration strategies has fuelled the interest in the consideration of multilateral decision-making in the analysis of FDI.

From an empirical point of view, some recent papers address the issue of spatial linkages when it comes to making decisions on FDI location. Using spatial econometric techniques, most of them pay attention to spillovers and/or linkages between countries, namely Blonigen, Davies, Waddell and Naughton (2007), Baltagi et al. (2007), Garretsen and Peeters (2009), Poelhekke and van der Ploeg (2009), Martínez-Martín (2011), Nwaogu and Ryan (2014), Regelink and Elhorst (2015), Badinger and Egger (2016), Alamá-Sabater, Heid, Jiménez-Fernández and Márquez-Ramos (2017), Siddiqui and Iqbal (2018), and Gutiérrez-Portilla, Maza and Villaverde (2019a). Between these papers, Blonigen et al.'s stands out as one of the most relevant. It estimates an extended spatial autoregressive (SAR) model to detect spatial linkages and, among other features, this article attracted attention since it offers a practical tool to identify FDI motivation: whether it is horizontal, vertical, export-platform or complex-vertical. Section 2 provides more detail on this issue.

Also, some papers apply Blonigen et al.'s approach to investigate spatial linkages at sub-national (e.g. regional) level, such as Ledyaeva (2009), Sharma, Wang and Sunny Wong (2014), Hoang and Goujon (2014, 2019), Esiyok and Ugur (2017), and Gutiérrez-Portilla, Maza and Villaverde (2019b).[2] There is a clear reason justifying a regional approach: the fact that this type of linkages is stronger the higher the level of data disaggregation, namely the smaller the unit of analysis. This is why many papers establish a clear link between spatial econometrics and regional economics; indeed, one of the most recent ones, published by Proost and Thise (2019) refers to regional economics as one of the constituent subfields of spatial economics.[3]

When dealing with FDI motivations at the regional level an important question arises: Should we apply Blonigen et al.'s approach as such? In this respect, all the aforementioned papers concur with Ledyaeva (2009) that the theoretical basis referring to the different types of FDI can be employed, overall, to regions, and so they do it. In our view, however, the direct implementation of this approach at a regional level is not trivial since some important nuances need to be borne in mind. For this reason, as indicated in Section 2 this paper is the first one attempting to differentiate the criterion at a sub-national level, trying to re-elaborate it when referring to FDI motivations between regions.[4]

Consequently, we adopt a regional perspective and, as said, drawing on a slightly different version of Blonigen et al.'s approach examine the determinants and motivation of UK investment into the Spanish regions (NUTS2) from 2000 to 2016. This case study is especially relevant. On the one side because the UK is, by far, the leading foreign investor in Spain. Specifically, according to figures from the Spanish Foreign Investment Registry (*DataInvex*), it accounts for 20.16% of total FDI flows received by Spain, reaching a value of 48,275 million euros over the period 2000-2016, while those from France represent only 12.32% of total FDI; the third country in the ranking, the USA, accounts for 10.69%. On the other side, this case study is nowadays especially appealing because the Brexit is expected to lead, for several reasons, to a decline in UK direct investment abroad (see, e.g., Bergin, García-Rodríguez, Morgenroth and Smith, 2017; McGrattan and Waddle, 2017; Delis, Driffield and Temouri, 2018; Dhingra, Ottaviano, Rappoport, Sampson and Thomas, 2018; Eichengreen, Jungerman and Liu, 2019). Putting two and two together, it is evident that knowing the factors driving UK direct investment is quite important, as this knowledge could help Spanish regions mitigate the potential negative impact of Brexit. As for the time period examined, it spans from 2000 to 2016. On the one side, the year 2000 stands out for the increase in UK investment into Spain, both in absolute and relative terms (e.g. 58.6% of total FDI compared to 20.5% in 1999). On the other side, 2016 was the last year with data available at the time of the analysis. Additionally, in our view, this time span is quite pertinent as it considers two different phases of the business cycle of approximately the same length and allows us to capture the impact of the 2008 recession, which will be accounted for in the model by including time fixed effects.

In addition to providing a new interesting case study, we want to point out that, apart from those related to the setting – regional vs. national – already mentioned, there are further differences between Blonigen et al.'s approach and ours. In this respect, we would like to stress that the contribution of the paper to the empirical literature on FDI determinants is threefold. Firstly, it estimates a spatial Durbin panel model (SDM) rather than the aforementioned standard SAR model extended by the inclusion of the surrounding market potential variable (see Equation 2 below).[5] By doing so, spillovers arising from other independent variables - apart from market potential - are not overlooked. We think, as indicated by Brakman, Garretsen and van Marrewijk (2009), that there is no reason to limit spatial externalities to one single channel, so this paper considers multiple channels. In fact, the New Economic Geography literature (Fujita et al., 1999) also refers to spillovers from other FDI determining factors, such as the ones included, as we will see later, in our proposed model: namely, wages, infrastructure and human capital. Let us consider, for instance, that FDI is seeking low wages; in this case, an increase in wages in the remaining regions would obviously boost FDI to the regarded one. As for infrastructure, needless to say that the existence of good infrastructure in neighbouring regions may be, on the other side, an incentive for FDI; that is, provided that strategies such as export-platform FDI and/or complex-vertical FDI are dominant, an improvement in infrastructure in the rest of regions could push up FDI. Regarding human capital, if FDI were seeking highly skilled workers, an increase in this variable in other regions would likely discourage FDI towards the region under analysis; this effect, however, is not quite clear because one could also argue that human capital improvements in one region may have positive externalities on others. In any case, what seems to be obvious is that strong reasons are underpinning an improvement in Blonigen et al.'s approach not to overlook these potential spillovers.

Secondly, another methodological contribution of the paper lies in the explicit treatment of feedback effects. By using point estimates, we compute the so-called average direct, indirect and total effects for each variable. New developments by LeSage and Pace (2009) show that they are more valid than the standard point estimates - to measure the effects on the dependent variable arising from changes in the independent ones - since they consider feedback links from neighbouring locations.[6]

Thirdly, this paper is unique in that, along with average effects, it also offers individual direct and indirect (spillover) effects for each region/pair of regions. To the best of our knowledge, there are just two papers that, although for other issues and not so thoroughly because they only pay attention to specific variables (Gutiérrez-Portilla, Villaverde, Maza and Hierro, 2018; Gutiérrez-Portilla, Maza and Villaverde, 2019c), delve into the components of the average effects. This contribution is, in our view, quite important, as it allows the researcher to better understand the role of FDI drivers. If apart from average effects showing what could be called the representative response of FDI to its determinants at the aggregate level, the analysis is supplemented by estimates for specific pairs of regions, it becomes certainly much more illustrative. The reason is quite simple: it will be able to unmask regional differences that, in many cases, can be quite significant.

The remainder of the paper is organised as follows. The next section gives a brief overview of the empirical approaches devoted to testing the explanatory power of the theoretical determinants of FDI, from non-spatial to spatial ones. There is a focus on Blonigen et al. (2007)'s spatial approach and subsequent criterion for assessing the FDI motivation. In line with previous comments, this approach is extended to include spillovers in all independent variables, and the criterion adapted to a regional scenario. The third section presents the model specification used in this paper as well as the data employed. The fourth section discusses the empirical results both at the aggregate and individual (region/pair of regions) levels. Finally, the last section offers some concluding remarks.

2. Different approaches to FDI: A brief outline

2.1. Standard Two-Country Approach

Traditional theoretical models of FDI have been developed in a two-country setting. Based on this theory, therefore, empirical approaches ignore the influence of other countries. Consequently, any standard two-country model proposes, in general terms, an equation as follows:

$$FDI = \propto_0 + \propto_1 \, Host\, Variables + \varepsilon \qquad (1)$$

according to which (inbound or outbound) FDI in a country depends on a vector of host variables that varies according to the case/model. For the sake of simplicity (for a broad review of FDI theories see, e.g., the surveys by Blonigen, 2005; Faeth, 2009), we pay attention only to the well-known OLI (ownership (O), location (L) and internalization (I) advantages) eclectic paradigm of international production developed by Dunning (1980), which to a certain extent combines many other approaches. More specifically, due to the aim of this paper, we focus on location advantages, either economic, political or sociocultural. For a summary, Table 1, taken directly from UNCTAD (1999), includes likely the best synthesis of these location advantages; as can be seen, the economic ones can be divided into three categories - market-seeking, resource/asset-seeking, and efficiency-seeking determinants -, the first one related to horizontal FDI and the other two to vertical FDI.

INSERT TABLE 1 AROUND HERE

From a methodological point of view, any version of Equation (1), due to the fact that outcomes for different units of observation (mostly countries as we said) are assumed to be independent, is usually estimated by Ordinary Least Squares (OLS), or any other traditional estimation technique. As for the economic meaning of the point estimates (coefficients linked to each independent variable), they can be interpreted as partial derivatives, so in terms of marginal effects; i.e. as the effect of a one-unit change in the independent variable on the dependent one.

2.2. Approaches Including Third-Country Effects: Blonigen et al.'s Criterion for FDI Motivation Adapted at Regional Level

As mentioned in the Introduction, new FDI models highlight the relevance of third-country effects, the existence of spatial linkages when it comes to identifying FDI determinants. In other words, it is accepted that FDI between two countries also depends on FDI in other countries, especially FDI in nearby ones, which implies the use of spatial models.

In this line, we take Blonigen et al. (2007)'s paper as our point of reference. It estimates a spatial model on FDI determinants that reads as:

$$FDI = \propto_0 + \propto_1 Host\ Variables + \propto_2 Surrounding\ Market\ Potential + \rho WFDI + \varepsilon \qquad (2)$$

where (1) the set of host variables is once again chosen based on theory (or prior empirical studies); (2) W denotes the (row-normalised) spatial lag weighting matrix so that $WFDI$ is the distance-weighted average of the FDI received by neighbouring countries; and (3) the so-called surrounding-market potential is defined as the distance-weighted average of the market potential of nearby host countries (the variable usually employed to proxy market potential is the GDP). As can be seen, in this model the role played by the distance weight matrix W is instrumental. It gives more weight to nearby than to distant observations, and it is employed to assess the influence on the FDI of any country that is exerted by the FDI and market potential of its neighbours. If, as usual, the matrix is row-normalised, the parameter ρ has an upper bound and picks up the interactions between any spatial units as a weighted average of their neighbours.

Here, and from a methodological perspective, using OLS provides inconsistent coefficient estimates due to the link between the error term and the spatial lag of the dependent variable. Among the alternatives, Maximum Likelihood (ML) estimation is preferred in the spatial econometrics literature. As for the interpretation, the usual one of a coefficient in terms of marginal effects is no longer valid. This is since the presence of spatial dependence (when the coefficient of the spatial lag of the dependent variable is different from zero) causes that changes in an independent variable for a single country may affect the dependent variable in all other countries, and point estimates do not consider these potential feedback effects. Consequently, the so-called direct and indirect effects have to be computed (LeSage & Pace, 2009). As a reference, although this is not the model we are finally going to estimate, in a standard SAR model the so-called matrix of effect estimates $S_r(W)$, which provides the marginal effect of, in this case, any host variable *r*th on FDI, is $S_r(W) = (I_n - \rho W)^{-1}[I_n \beta_r]$, being ρ the spatial autoregressive coefficient, $(I_n - \rho W)^{-1}$ the so-called spatial multiplier effect, β_r the coefficient linked to the *r*th independent variable, and I_n the identity matrix. Therefore, as $(I_n - \rho W)^{-1} = I_n + \rho W + \rho^2 W^2 + \cdots$, the first term of $S_r(W)$ computes the effect without considering space, the second refers to the effect of the first-order neighbourhood, and so on. Consequently, the main-diagonal elements of the matrix $S_r(W)$ are the own-partial derivatives (and their average is the so-called direct effect), while its off-diagonal elements are the cross-partial derivatives (and the average of their cumulative sum from each row is the indirect effect). Obviously, these off-diagonal elements are capturing spillover effects, as they are reporting that a change in the host variable *r*th for any location can have an impact on FDI in other locations.

Now we are moving to Blonigen et al.'s criterion for identifying the FDI motivation. According to their proposal, the sign of the coefficients on the two additional variables that are included in Equation (2) compare to Equation (1), namely the spatial lag of FDI and the surrounding-market potential variable, can be linked to the predominant FDI motivation. To be precise, the sign of ρ indicates whether there are patterns of complementarity or substitution in FDI and, by combining that with the sign of $\propto_2$ it is possible to determine the predominant FDI motivation that, as revealed in the Introduction, now becomes a fourfold classification: horizontal, vertical, export-platform or complex-vertical. In this paper, we use this approach as a benchmark, but pointing out that there are some specificities when applying it, as it will be the case in this paper, at the regional level (Table 2).

INSERT TABLE 2 AROUND HERE

One of the basic forms of FDI is pure horizontal or market-seeking FDI, which is mainly driven by market access. When there are high trade costs between the home and host locations, horizontal FDI is more desirable than trading. Given that this type of FDI is aimed at serving the various local markets, Blonigen et al.'s criterion suggests that neither FDI nor market size of potential neighbouring hosts should be relevant. However, at a regional level, we pose that though the coefficient linked to the spatial lag of FDI is still expected to be insignificant, the coefficient on the surrounding-market potential variable is expected to be positive. This is so because regions are relatively small, and therefore the size of local markets is not enough to justify FDI flows by itself.

In the case of export-platform FDI, the most preferred destination is used as a platform to export products to third markets. Since the MNE will not set a production facility in each host destination, a negative sign for the coefficient of the spatially lagged FDI variable is expected. Additionally, we would expect a positive correlation between FDI and the market size of neighbouring hosts. Here, as our case study deals with regions rather than countries, we rename this FDI motivation from 'export-platform FDI' to 'regional-trade platform FDI' (Ledyaeva 2009). Additionally, although it is not included in Table 2 to be consistent with our benchmark, export-platform FDI clearly benefits from good infrastructure services, so a positive coefficient is expected for the spatial lag of any infrastructure variable included in the model.

In the case of pure vertical FDI, the MNE establishes its production in the host location with the lowest factor costs. The spatial lag FDI coefficient is expected to be negative because FDI in one host destination will be at the expense of nearby potential destinations. Moreover, the variable capturing the surrounding-market potential should be, according to Blonigen et al.'s approach, insignificant since FDI is driven by factor cost differences rather than market size. Although we admit that the surrounding market potential variable may be non-significant, for the same reason put forward in the case of horizontal FDI we also believe that the corresponding coefficient could be positive when the analysis is carried out at the regional level. This being so, there would be kind of agglomeration effects within the country. Furthermore, although it is not included in Blonigen et al.'s criterion, to assess the case of pure vertical FDI a labour cost variable has to be included in the model. This being so, a negative coefficient is expected, as well as a positive one for the variable capturing labour costs in neighbouring regions. This is once again not included in Table 2 for consistency.

Finally, complex-vertical (or fragmentation) FDI takes place when the MNE sets up a vertical chain of production across multiple locations by looking for low-cost suppliers. In this case, we expect a positive coefficient on the spatially lagged FDI variable since having suppliers in neighbouring locations fosters FDI. As for the surrounding-market potential variable, its coefficient could be either positive or insignificant, depending on whether or not large surrounding markets help attract vertical suppliers and create agglomeration effects. Though once again it does not appear in Table 2, for the case of complex-vertical FDI it is obvious that to get an efficient chain of production good infrastructures are needed, so a positive coefficient is expected for the variable capturing it not only in the host location but also in neighbouring regions. Besides, more complex-vertical FDI is conducted in regions where labour is relatively cheap.

2.3. Blonigen et al.'s Approach at Regional Level: An Extension Including Additional Spatial Channels

In our view, Blonigen et al.'s approach was a significant improvement in the understanding of FDI determinants. There is no apparent reason, however, to limit spatial linkages to the two variables already mentioned. As explained in the Introduction, multiple spatial channels could be running at the same time and they would be disregarded if we kept the extended SAR model proposed in Equation (2). For this reason, we propose to estimate an SDM, which allows for a spatial relationship in all the independent variables, and would read as follows:

$$FDI = \propto_0 + \propto_1 Host\ Variables + \propto_2 Surrounding\ Market\ Potential + \rho WFDI + \theta W Host\ Variables + \varepsilon \quad (3)$$

where the only difference with Equation (2) lies in the fact that now the spatial lag of the host variables is also included. As indicated, this addition is especially pertinent when adopting, as in this paper, a regional rather than a national viewpoint since spatial interactions are much more likely and intense. Not only this, as Elhorst (2010, p. 10) indicates, 'one strength of the spatial Durbin model is that it produces unbiased coefficient estimates also if the true data-generation process is a spatial lag or a spatial error model. Another strength is that it does not impose prior restrictions on the magnitude of potential spatial spillover effects'.

Due to this extension of the model, it is important to point out that now the matrix of effect estimates to compute direct and indirect effects becomes $S_r(W) = (I_n - \rho W)^{-1}[I_n\beta_r + W\theta_r]$, where θ_r refers to the coefficient linked to the spatial lag of the *r*th independent variable (Elhorst, 2014). As can be seen, in this case both direct and indirect effects of an independent variable depend not only on the parameter ρ and W but also on the coefficient θ_r.

Finally, we want to stress here an issue, highlighted by Gibbons and Overmans (2012), which can be considered as a general critique to spatial econometrics regardless of the model used: we are referring to endogeneity and the problems of identification and, ultimately, causality. This is connected to Manski's (1993) reflection problem, that endogenous and exogenous interaction effects cannot be distinguished from each other. As Gibbons and Overman (2012) indicate in a meaningful appendix, the use of an SDM model does not solve the problem whether the causal effect of the observed spatial patterns in the data is due to endogenous interaction effects or interaction effects among the error term. This point, no doubt, implies that cautionary caveats on interpreting the results are necessary.

Having said that, there are two important points we want to highlight. On the one hand, a key question when it comes to identification is whether W is correctly specified. In this paper, as we will see below, it is important to note that, apart from choosing it from an econometric criterion that, we have to admit, is not in line with Gibbons and Overman (2012)'s postulates, we also try with alternative specifications, from standard distance matrices to even economic distance matrices, being the results quite consistent. This fact, in our view, gives a good deal of robustness and reliability to the results. On the other hand, we are in line with Arbia (2016) when he, admitting that Gibbons and Overmans (2012)'s criticisms are well-grounded, poses that 'they lose relevance if we abandon the (alas, still prevailing!) narrow paradigm of a discipline centered on the regression analysis of regional data, and we embrace the wider definition originally proposed by Paelinck and Klaassen (1979)' (Arbia, 2016, p.7).

3. Model and Data

Moving from a general to a specific model in which the vector of host variables has already been chosen, Equation (3) becomes as follows:[7]

$$FDI_{it} = \beta_1 GDP_{it} + \beta_2 Wage_{it} + \beta_3 Hc_{it} + \beta_4 Infr_{it} + \rho \sum_j w_{ij} FDI_{jt} + \theta_1 \sum_j w_{ij} GDP_{jt} + \theta_2 \sum_j w_{ij} Wage_{jt} + \theta_3 \sum_j w_{ij} Hc_{jt} + \theta_4 \sum_j w_{ij} Infr_{jt} + \beta_5 d_{chartered} + \mu_t + \varepsilon_{it} \tag{4}$$

where FDI_{it} denotes FDI stock[8] from the UK to the Spanish region i at year t, expressed in thousand euros of 2000 (in logs). The literature is split regarding the use of FDI flows or stocks, but our choice, in line with Blonigen and Piger (2014), was dictated by the aim of assessing 'the long-run factors that explain the distribution of FDI' (Blonigen & Piger, 2014, p. 782). FDI data is, as mentioned in the Introduction, collected from the Spanish Foreign Investment Registry (*DataInvex*).[9] As for the independent variables, we select traditional host variables in light of the literature on FDI determinants at the regional level (Table 3 gives the definitions and sources of these variables):

INSERT TABLE 3 AROUND HERE

- GDP refers to Gross Domestic Product and is used as a proxy for market potential. It is considered a market-seeking location advantage in the OLI eclectic paradigm aforementioned (Dunning, 1980; 1988). Within the framework of the new trade theory, which combines ownership and location advantages with technology and country characteristics, GDP is a determinant for FDI as well (Faeth, 2009). Hence, regions with high GDP usually have a greater demand for goods and services, so they are expected to receive more FDI. Having said that, we have to admit that some toning down is in order as for the relevance of this determinant (e.g. Barba-Navaretti & Venables, 2004).

- $Wage$ refers to the annual wage per worker. Models put forward by Heckscher-Ohlin (Heckscher, 1919; Ohlin, 1933), MacDougall (1960) and Kemp (1964) claim that FDI is motivated by lower labour costs. According to the MNE general equilibrium theory (Markusen, 1984; Helpman, 1984), vertical FDI looks for low wages in the production process. Additionally, the OLI paradigm highlights low costs as an asset-seeking location advantage, that is, a reason to undertake FDI and produce abroad. Therefore, wages are expected to have a negative effect on FDI as long as the investment is seeking out low labour costs.

- Hc represents human capital. Another asset-seeking location advantage according to the OLI framework lies in the possession of intangible assets, such as human capital. Markusen and Venables (1998) also refer to skilled labour as an important factor endowment to understand MNEs activity in a general equilibrium model. It is generally postulated that better education and training means increases in productivity and, therefore, attracts FDI. Then, a positive effect is expected.

- $Infr$ is the infrastructure endowment. In the same vein, OLI paradigm underlines the role played by transportation and communications infrastructure as an asset-seeking location-specific advantage; namely, locations with low transport costs derived from an adequate endowment of infrastructure are likely to attract more FDI. So, a good infrastructure is expected to foster FDI attraction.

- $d_{chartered}$ is a dummy variable for the chartered regions (Navarra and País Vasco) trying to capture what Tuman and Erlingsson (2019) refer to as 'subnational policy environment'; namely, tax differences existing within Spain that, in this case, should not be disregarded. Due to the *foral* or *cupo* applied to these Autonomous Communities, Navarra and País Vasco may keep, establish, and regulate, within their territory, their tax systems, provided they are subject to some limits.[10] Namely, unlike the remaining regions in Spain, both Navarra and País Vasco decide on the degree of fiscal pressure as well as collect their own taxes. Because of this, they have independent, more favourable and lenient for FDI, tax systems. As a way of illustration, the corporation tax rate is lower in these two regions than in the rest of Spain, and they have pursued some tax measures aimed at attracting investment. In Martínez-Barbara words (Martinez-Barbara, 2016, p. 162), this situation 'makes the Basque region a rare bird, only comparable to Navarre, among European regions'. As for the sign of the corresponding coefficient, informed by the literature on the link between taxes and FDI (for a meta-analysis, see Feld & Heckemeyer, 2011), a positive sign is expected as the lower the taxes the higher the level of FDI.

- μ_t denotes time-fixed effects, included to control temporal changes over the period of study. As it includes the crisis years interfering in 2000-16, with an important effect on FDI flows all over the world (Gil-Pareja, Llorca-Vivero and Paniagua, 2013; Delis et al., 2018), their inclusion turns out to be mandatory.

Finally, to compute the spatial lags of the dependent and independent variables (apart from the dummy for obvious reasons), it is necessary to deal with the specification of the spatial weight matrix W, whose elements (w_{ij}) give more weight to nearby than to distant observations. Following the criterion based on the highest value of the log-likelihood function (Elhorst, 2010), we pick the inverse distance matrix - by employing geographic distances in km between the corresponding regional capitals' centroids - for the spatial lag of the independent variables, which is normalised by its largest eigenvalue (Kelejian and Prucha, 2010).[11] It is important to stress that we do not use the standard row-normalised spatial weight matrix (for which the sum of each row equals one) since it is no longer symmetric. In other words, when employing the common practice of row normalisation the resultant model is not equivalent to the original one (with un-normalised weight matrix) and, therefore, there is a loss of economic interpretation in terms of distance decay. As indicated by Kelejian and Prucha (2010, p. 56) 'unless theoretical issues suggest a row-normalized weight matrix, this approach will in general lead to a misspecified model'. Hence, a single normalisation factor has to be employed to preserve the interpretation of the distance decay function.

4. Regression Results

4.1. Aggregate results

The first part of Table 4 reports the results of Equation (4), estimated by ML. Looking at the point estimates, the first thing to note due to its implications when unveiling the FDI motivation is that there is a link between FDI in a region and FDI in neighbouring locations. Although it is smaller than in many other papers, ρ coefficient (0.11) is statistically significant at the 1% level. As for the FDI drivers, our results seem to indicate that market potential, wage, human capital and infrastructure endowments of the host region together with human capital, wages and infrastructure of neighbouring regions matter for the attraction of FDI. Moreover, the more lenient tax systems of Navarra and País Vasco make them, as expected, more attractive to FDI.

However, as mentioned in Section 2, these point estimates may provide misleading insights as they do not represent true partial derivatives and, for this reason, they cannot be interpreted in terms of marginal effects. Consequently, we compute direct and indirect effects by simulating parameters using the maximum likelihood multivariate normal parameter distribution and the mixed analytical Hessian (LeSage & Pace, 2009). The total effect is the sum of the direct and indirect effects.

Firstly, we are interested, as usual in the literature and in line with the information proxied by the point estimates, in calculating the average values, i.e. single figures that can be taken as a reference for the magnitude of these effects (columns two to four of Table 4). LeSage and Pace (2014, p. 246) point out that 'scalar summary measures of the impacts that average over all observations are more consistent (*than those made at observation-level*) with typical regression model uses and interpretation'. In any case, in the last part of this section, we delve into the results for each region (individual direct effects) or pair of regions (individual indirect effects).

To properly understand the results, it is pertinent to start with definitions. The direct effect captures the impact of a change in the corresponding independent variable in a region i on the

FDI received by that region. Therefore, to yield a representative figure the average direct effect is computed by averaging those obtained for each one of the 17 Spanish regions. These effects are reported in Table 4, second column. The indirect or spillover effect measures the impact on the FDI of any specific region of changes in the corresponding independent variable in all the remaining 16 regions. In other words, it is an aggregated effect computed as the sum of single indirect effects between the region under analysis and each one of the rest of regions. Again, a representative figure is obtained by averaging those obtained for each region. The third column of Table 4 shows this average indirect effect.[12]

Moving on to these more accurate results on the FDI drivers, and starting with the market potential variable, its role as an FDI attraction factor is confirmed. Additionally, the breakdown of the total effect indicates that FDI is mainly affected by the host region's market potential, playing that of neighbouring regions a much less relevant but, anyway, significant and positive role.

As for the wage variable, its total effect (but especially the direct one again) turns out to be negative and statistically significant, which indicates that FDI is looking for low labour costs. It is important to remark that the spillover effect is also negative which, from an economic point of view, can be interpreted as regions not competing strongly in terms of wages, but having a kind of complementary relationship. We will delve into this issue when talking about FDI motivation. Concerning human capital, the total effect is not significant, though the corresponding breakdown conveys the message that this is because the (small) direct and indirect effects cancel each other out. Besides, when comparing the results obtained by wage and human capital variables, you immediately get the conclusion that UK MNEs pay more attention to the former; intuitively, it could be related to the regional differences existing in these two variables, which are more significant in labour costs than in the levels of high-skilled population.

As expected, well-developed road infrastructure fosters FDI location, both in the host and the neighbouring regions. It is essential to note here that the indirect effect is much more powerful than the direct one, namely infrastructure generates more spillover effects on FDI than any other variable. This is an expected result as an improvement in infrastructure endowments in any region reduces transportation costs in all regions sharing the same grid as well as provides better accessibility to markets to neighbouring ones. Consequently, our findings highlight the importance of the striking transformation of Spanish infrastructure that took place in recent decades, with a modern network of motorways, airports and high-speed railway lines.

Moving on to the FDI motivation, remember we have to pay attention to the spatial lag of FDI along with the surrounding-market potential variable (Table 1). As mentioned, the coefficient linked to the spatial lag of FDI is positive and statistically significant, which indicates the existence of spatial linkages in FDI across the Spanish regions. Drawing from Blonigen et al. (2007), and Garretsen and Peeters (2009), this complementary relationship, together with the positive and statistically significant spillover effect of market potential point out to a complex-vertical FDI motivation. The results for wages support this finding since there is a significant negative direct impact of wages on FDI along with, although to a lesser extent, also negative (rather than positive as in pure vertical FDI) spillover effects. This circumstance conveys the idea that when neighbouring regions have also low labour costs a complex production-system chain, ultimately involving major UK multinational enterprises, is set up. Not only this, but infrastructure findings also match a complex-vertical FDI motivation since, as indicated, in this case spatial spillovers are very important, being the existence of a good infrastructure network a necessary condition for this type of FDI.

INSERT TABLE 4 AROUND HERE

Before finishing, it seems appropriate to compare our results with those obtained by estimating an extended SAR model (the second part of Table 4). For simplicity, we just highlight the differences between the two models. The main ones are the following: 1) As for the goodness of fit, it is much higher in the SDM than in the SAR model, so we can assert that the former is more accurate than the latter; 2) The SAR model points to positive human capital spillovers on FDI, while they are negative according to the SDM. The interpretation of this result is that the standard approach is here masking the fact that regions, when it comes to FDI, are competing in terms of human capital. In other words, when (mistakenly in this case) you estimate an extended SAR model you can get the wrong conclusion that any increase in the level of human capital in neighbouring regions will drive FDI to your region, being this only a weak (as shown by the SDM results) agglomeration effect due to spatial dependence on FDI. Indeed, it is completely outweighed by the fact that, actually, if a region is surrounded by others where workers qualification rises, it will receive, for competition reasons, lower levels of FDI. The inclusion of the parameter $W\theta_3$ in the spillover effect (see Section 2) is providing us with this important piece of information; 3) There are also quite remarkable differences regarding the statistical significance and magnitude of the coefficients between models. As expected, they are especially notable in terms of spatial spillover effects.

Another pertinent comparison here is one concerned with previous papers mentioned in the Introduction. Those results are varied and, as expected, have yet to produce a unified finding. Put differently, all empirical evidence underlines the fact that results depend on the case study. Therefore, without pretending to be too exhaustive, we only want to highlight here that when jumping from a national to a sub-national (mainly regional) perspective, the standard FDI motivations (horizontal and vertical) seem to vanish. All the aforementioned papers at sub-national level find a trade-platform oriented FDI or a complex vertical FDI. This is line with the existence of third-effects taking the form of linkages between host locations, which are much more likely at the regional level.

Finally, before going any further, it is important to check for the robustness of the results. As can be seen in the Appendix, the check is fivefold and, for the sake of simplicity, we only show (direct, indirect and total) effects and the coefficients for the spatial lag of the dependent variable and the dummy variable for the chartered regions. We test: 1) The use of different distance matrices, both with geographical and economic distances; 2) The inclusion of the geographical distance between each Spanish region and London; 3) The consideration of specific features of island regions (Canarias and Baleares); 4) The use of alternative definitions for the infrastructure variable; 5) The use of more disaggregated data. Although there are always some slight differences, these results are quite robust regardless of the case. Therefore, in the next sub-section, we go on with the benchmark model of the paper.

4.2. Individual results

As mentioned above, we want to go a step forward by examining potential regional differences in the various FDI determining factors, for which we need, rather than the previous average effects, to get specific values for the direct effect corresponding to each region and the indirect effects for each pair of regions.

In any case, we want to stress again that the average effects proposed by LeSage and Pace (2009) represented an improvement over the standard point estimates since, as said, they include feedback loops that may be quite significant. Feedback effects arise because of impacts passing through neighbouring regions and coming back to the region where the change originated from (Halleck Vega & Elhorst, 2015). LeSage and Pace themselves reveal (Section 3.4 of their book, p. 68 et seq.) the important discrepancies between the coefficients and the average impact estimates, pointing out that this is a frequent mistake made by practitioners. Not only this, but there are also quite a few empirical studies on various topics (too many to be cited here) showing that feedback effects can be instrumental, especially when measuring spillovers.

Without doubting about the importance of the average effects, what we want to emphasise here is that they are also subject to some pitfalls mainly because, for a variety of reasons (different types of FDI or agglomeration processes depending on the area, for instance), they are not always an accurate indicator for all regions. Furthermore, in some cases, researchers are interested in either one single region or even in knowing what we call an individual effect, which is the effect of a change in a specific region on another one. For this reason, we argue that although average effects are a good way to summarise results, they should be supplemented with individual ones. To do so, Tables 5 to 8 report the matrix of effect estimates $S_r(W)$ – explained in Section 2 - of FDI concerning the independent variables included in Equation (4). Consequently, each shaded cell (diagonal elements) records the own response of FDI in that region to a change in the corresponding FDI determinant in the same region, while each of the non-shaded cell (non-diagonal elements) captures spillover effects, that is to say, the response of a region to a change in the FDI determinant in another one.

INSERT TABLES 5 TO 8 AROUND HERE

Looking at these matrices, we can draw three general conclusions. First, whatever the variable, the highest values coincide with the diagonal. It is also important to note that regional differences are not very significant regarding these direct effects. Second, moving to cross-partial derivatives or spillovers for every single unit, i.e. at the observational level, it can be seen that differences become significant and the highest values (in absolute terms) are those of nearby regions. Third, the last column of each matrix displays the total spillover effects, revealing that Navarra, País Vasco and La Rioja are the regions with the strongest indirect effects. It is also important to highlight that Madrid always occupies a high position in the ranking.[13]

About specific comments for each region, needless to say that these would be cumbersome. In any case, the main added value of the matrix of effect estimates comes when you are especially interested in one single region. As a matter of example, let us consider the first row of the last matrix (Table 8), which reflects the effects on Andalucía of changes in infrastructure in all regions. As can be seen, the value of the direct effect (1.4720) is a little more than half of the total indirect one (it reaches a value of 2.6887); consequently, in terms of FDI Andalucía is not only affected by its internal situation but also by the infrastructure condition in the remaining regions. Certainly, by paying attention to the individual components of the indirect effect we can see that the highest single indirect effect corresponds to Extremadura (0.3133), followed by Castilla-La Mancha (0.2869) and Madrid (0.2457); therefore, it seems to be a straightforward conclusion that, when trying to attract FDI, Andalucía has to pay close attention to its connections with the capital of the country through Castilla-La Mancha and Extremadura.

Finally, as a way of summarising the results obtained and also to give the reader a geographical picture of the relevance of the total effects by region, Figure 1 displays three maps corresponding to the impact of market potential, wages and infrastructure on FDI (human capital is not displayed because its average total effect is not statistically significant, as can be seen in Table 4). Note that the darker the colour, the higher the total effect (in absolute terms). Significant regional differences can be seen. Lower absolute values correspond, for the three variables, to peripheral regions such as Baleares, Canarias and Galicia. This finding is not, after all, entirely unexpected, as it seems to point out that outlying regions need complex strategies to attract FDI. Economic intuition tells us that they call for integration into large networks and production chains, which, and this is good news, fits in with the main motivation of UK FDI located in Spain. On the other side, País Vasco, Navarra and La Rioja are, in all cases, among the regions with the highest absolute values, mainly due to the importance of spillover effects mentioned above; Madrid and Castilla-La Mancha also stand out, especially in the case of infrastructure. There seem to be, somehow, two groups. The first one is made up of the two regions with different tax regimes along with La Rioja, which are relatively similar from social/cultural and economic viewpoints. The other group is made up of Madrid and neighbouring regions, due largely to the existence of good infrastructure (for instance, the so-called 'Corredor de Henares' sets a good example of linkages between Madrid and Castilla-La Mancha).

INSERT FIGURE 1 AROUND HERE

5. Conclusions

Understanding the factors driving FDI has been a subject of intense debate and research in the economic literature. In this respect, however, the role of spatial interactions across FDI-hosting territories has been largely overlooked. To overcome this drawback, this paper employs a case study that, apart from interesting nowadays, is quite pertinent to illustrate these spatial linkages: UK direct investment in the Spanish regions over the period 2000-16. More specifically, the present paper, unlike mainstream on this issue, estimates a spatial Durbin panel model to include spillover effects coming from multiple spatial channels. This issue turns out to be especially pertinent, for reasons given in the Introduction, when the paper adopts a regional approach. In addition, it computes, apart from point estimates, the well-known direct, indirect and total effects to get more accurate results. Moreover, and truly important, it presents individual effects for each pair of regions.

In doing so, the aim of the paper lies in identifying the key drivers of FDI and, accordingly, its main motivation. By applying a somewhat different version of Blonigen et al.'s (2007) typology, we see neither of the two traditional FDI motivations (pure horizontal/pure vertical) seems to prevail. The results reveal a pattern of complementarity in FDI (the spatial lag of FDI turns out to be positive and statistically significant), which is the major feature for engaging in complex-vertical FDI. Accordingly, most UK multinational enterprises seem to establish a vertical chain of production across various Spanish regions to take advantage of differences in factor prices. Furthermore, the findings point out to the presence of positive spillovers of market potential on FDI which, in line with the extension of Blonigen et al.'s (2007) framework developed by Garretsen and Peeters (2009), indicates extra FDI coming from vertical suppliers and, hence, agglomeration effects. In addition to market potential, it is important to highlight that other variables such as wage and infrastructure, not only in the host region but also in the remaining ones due to the presence of spatial spillovers, which are especially intense in the case of infrastructure, emerge as key drivers of UK direct investment in Spain. Finally, the computation of the effects for each pair of regions brings to light the existence of important differences regarding spillovers; in particular, it shows that they are especially strong for some regions in the North of Spain (País Vasco, Navarra, and La Rioja), as well as Madrid and its closest regions with regard to infrastructure.

Accordingly, from a policy perspective, our findings do not just call for specific/regional policies to mitigate the unwelcome side effect that the Brexit will likely have on FDI flows coming from the UK to Spain. As long as attracting FDI is one of the main issues of the Spanish economic agenda, and will most likely remain so in the years to come, regions must take into account their complementarities in order to pursue joint FDI policies. MNEs success is always embedded in the socio-economic environment in which they are operating so that regions should be able to create a well-functioning system that helps firms to exploit new business opportunities; in so doing, they will be able to attract more FDI.

More specifically, when it comes to implementing these joint regional policies to create a good environment for MNEs and attract foreign direct investment the existence of remarkable regional differences, which we have been able to uncover, has to be taken into account. In other words, distinctive policy nuances and recommendations depending on the group of regions at hand should be implemented. Setting Madrid and Castilla-La Mancha as an example, our findings reinforce the well-established view that the ongoing improvement in infrastructure (both in the number of kilometres and in quality) has had – and will keep on having – quite positive effects on, among other issues, their capacity to attract FDI. The same measure in a peripheral region such as Galicia would not have had, according to our results, such as intense effect. Henceforth, infrastructure investments, as well as other kinds of investment, should be tailored to enhance the strengths or soften the weaknesses of each region.

In any case, we still have to admit that more intensive research would be needed to gain a better understanding of the roots of these spatial linkages between regions, and then about the proposal of feasible policies to attract FDI. Needless to say, getting access to more disaggregated data would be very useful to be more conclusive about these issues. One interesting extension of the paper would be to perform the analysis by differentiating between merger and acquisitions and greenfield investment (new ventures), as they are not perfect substitutes (Guadalupe, Kuzmina & Thomas, 2012). In our view, spillovers might be even higher if only new venture firms were included; these firms are in themselves a mechanism for the existence of spillovers because they pave the way for new similar investments not only in the same region but also in others. Another further natural extension of this paper would be to redo the analysis at the provincial (NUTS3) level or, even better, at the firm level, that is, with individual data for the different UK (nearly 1000) companies located in Spanish regions.[14] As it is obvious, the finer the disaggregation the more relevant the analysis of spatial spillovers would be and, consequently, policy suggestions would be able to get more to the point.

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[1] Antras and Yeaple (2014)'s paper stresses the fact that 'these models also highlight some of the shortcomings of two-country models by showing how the characteristics of a country's neighbourhood can affect the structure of its trade and multinational activity' (Antras & Yeaple, 2014, p. 96).

[2] Other papers adopting an alternative spatial approach are Coughlin and Segev (2000), Kayam, Yabrukov and Hisarciklilar (2013), Blanc-Brude, Cookson, Piesse and Strange (2014), Casi and Resmini (2014), and Villaverde and Maza (2015).

[3] Griffith and Paelinck (2007, p. 209) state that 'when coining the term spatial econometrics in 1979, Paelinck and Klaassen characterized it as a subset of econometrics that is concerned with the role of spatial dependence in regional economic model response and explanatory variables'. LeGallo, Ertur and Baumont (2003, p. 106) assert that 'Spatial dependence means that observations are geographically correlated ... Several economic factors, like labour force mobility, capital mobility, technology and knowledge diffusion, transportation or transaction costs may be particularly important because they directly affect regional interactions'. Therefore, there is no doubt, in our view, about the pertinence of dealing with FDI motivations at a regional level.

[4] Apart from the one related to the criterion used to determine FDI motivation, there is another important difference between a national and regional setting, which simplifies the analysis: in the second one there are some factors (tariffs, for instance) that, being the same or rather similar for every region within a country, do not need to be regarded.

[5] In any case, this is not the first paper using an SDM to distinguish between the different types of FDI motivation, as Siddiqui and Iqbal (2018), and Gutiérrez-Portilla, Maza and Villaverde (2019a) also employ it; on the other side, Kayam et al. (2013) also estimate an SDM to assess FDI determinants.

[6] The marginal effect of an independent variable on the dependent one is not equal to the estimated parameter when spatially lagged dependent or spatially lagged independent variables are present.

[7] Apart from the economic reasons given above, we also adopted an econometric-based approach to make sure of the suitability of the proposed SDM. To do so, we computed the corresponding Likelihood Ratio (LR) specification test to assess whether the proposed SDM could be simplified into the standard SAR model (or even into a spatial error model (SEM)). The results, available upon request, clearly indicate that the null hypothesis can be rejected in both cases, revealing consequently that an SDM actually performs better than the SAR model (and also than the SEM).

[8] Since data on FDI stock for each year are not available, we proxy it by using the accumulated sum of gross FDI flows from 1993 to that particular year. We tried with different depreciation rates, but the results do not significantly depend on the one you employ.

[9] This data source allows us to consider only productive FDI, so that investment corresponding to foreign stock holding companies, whose 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. This data bank also reports information at the sectoral level, according to which FDI in services accounts for nearly 87% of total FDI, the share for industry being over 11%.

[10] In late 90's, for example, there were some economic measures aimed at attracting investment, but the European Union declared them illegal later. These measures included tax incentives for investment and the so-called 'tax holidays'.

[11] For the dependent variable we employ, as it is commonly done and for the sake of comparison, a row-standardised distance weight matrix.

[12] It is important to highlight that, with regard to the indirect effect, we followed LeSage and Pace (2009) despite the fact that it has a drawback: as a cumulative effect, it increases with the number of regions in the cross-section, what has to be taken into account when interpreting it. An alternative definition would be to consider, for each region, the average of the single indirect effects rather than their summation.

[13] As we have a symmetric distance matrix, it is not possible to separate indirect effects between spill-in and spill-out effects (LeSage & Chih, 2016).

[14] Provided these data were available, we could not only re-do the analysis but also, getting back to identification problems arose by Gibbons and Overmans (2012), change the strategy and employ a regression discontinuity research trying to identify discontinuities in FDI received by firms at provincial borders.

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TABLE 1. HOST COUNTRY/REGION DETERMINANTS OF FDI

Host country determinants	
I.	Policy framework for FDI
•	Economic, political and social stability
•	Rules regarding entry and operations
•	Standards of treatment of foreign affiliates
•	Policies on functioning and structure of markets (especially competition and M&A policies)
•	International agreements on FDI
•	Privatization policy
•	Trade policy (tariffs and NTBs) and coherence of FDI and trade policies
•	Tax policy
II	Economic determinants
III	Business facilitation
•	Investment promotion (including image-building and investment-generating activities and investment-facilitation services)
•	Investment incentives
•	Hassle costs (related to corruption, administrative efficiency, etc.)
•	Social amenities (bilingual schools, quality of life, etc.)
•	After-investment services

Type of FDI classified by motives of TNCs		Principal economic determinants in host countries
A	Market-seeking	• Market size and per capita income • Market growth • Access to regional and global markets • Country-specific consumer preferences • Structure of markets
B	Resource/asset-seeking	• Raw materials • Low-cost unskilled labour • Skilled labour • Technological, innovatory and other created assets (e.g. brand names), including as embodied in individuals, firms and clusters • Physical infrastructure (ports, roads, power, telecommunication)
C	Efficiency-seeking	• Cost of resources and assets listed under B, adjusted for productivity for labour resources • Other input costs, e.g. transport and communication costs to/from and within host economy and costs of other intermediate products • Membership of a regional integration agreement conductive to the establishment of regional corporate networks

Source: UNCTAD (1999)

TABLE 2. FDI MOTIVATION AND HYPOTHESIZED SIGNS OF THE COEFFICIENTS SPATIAL LAG AND THE SURROUNDING-MARKET POTENTIAL COEFFICIENTS. AN ADAPTATION OF BLONIGEN ET AL.'S APPROACH TO A REGIONAL SCENARIO

FDI motivation	Sign of spatial lag	Sign of surrounding-market potential variable
Pure horizontal	0	+†
Regional-trade platform‡	−	+
Pure vertical	−	0/+§
Complex-vertical	+	0/+

Notes: (†) For the case of countries it is expected to be non-significant; (‡) Export platform when dealing with countries; (§) For the case of countries it is expected to be always non-significant.
Note: 0 denotes non-statistical significance. Source: Own elaboration based on Blonigen et al. (2007).

TABLE 3. VARIABLES: DEFINITION AND SOURCE

Variable	Definition	Source
GDP	Ln(GDP), expressed in thousand euros of 2000	Spanish National Statistics Institute
$Wage$	Ln(Wage per worker), expressed in thousand euros of 2000	Spanish National Statistics Institute
Hc	Human capital: Percentage of population aged 25-64 with upper secondary, post-secondary non-tertiary and tertiary education	Eurostat
$Infr$	Infrastructure: Ln(number of kilometres of motorways per thousand square kilometre)	Eurostat
$d_{chartered}$	Dummy variable: 1 for the chartered regions of Navarra and País Vasco; 0 otherwise	Authors' own

Source: Own elaboration.

TABLE 4. PANEL SPATIAL MODELS. AVERAGE RESULTS

Dependent variable: FDI_{it}	SDM				Extended SAR			
	Point estimate	Direct effect	Indirect effect	Total effect	Point estimate	Direct effect	Indirect effect	Total effect
GDP_{it}	1.96***	1.97***	0.44**	2.41***	1.98***	1.98***	0.23**	2.21***
	(0.04)	(0.04)	(0.17)	(0.19)	(0.04)	(0.04)	(0.11)	(0.10)
$Wage_{it}$	-5.13***	-5.16***	-2.87**	-8.03***	-3.99***	-4.00***	-0.64**	-4.63***
	(1.60)	(1.60)	(1.24)	(2.21)	(1.46)	(1.46)	(0.34)	(1.72)
Hc_{it}	0.14***	0.13***	-0.17***	-0.04	0.12***	0.12***	0.02**	0.14***
	(0.03)	(0.03)	(0.05)	(0.05)	(0.02)	(0.02)	(0.01)	(0.03)
$Infr_{it}$	1.46***	1.49***	3.43**	4.92**	1.27***	1.27***	0.20**	1.47***
	(0.18)	(0.21)	(1.75)	(1.94)	(0.08)	(0.07)	(0.08)	(0.15)
$\sum_j w_{ij}\, FDI_{jt}$	0.11***				0.14***			
	(0.04)				(0.05)			
$\sum_j w_{ij}\, GDP_{jt}$	0.19				-0.08***			
	(0.15)				(0.01)			
$\sum_j w_{ij}\, Wage_{jt}$	-2.17**							
	(0.97)							
$\sum_j w_{ij}\, Hc_{jt}$	-0.19***							
	(0.05)							
$\sum_j w_{ij}\, Infr_{jt}$	3.19**							
	(1.56)							
$d_{chartered}$	0.80***				0.53***			
	(0.07)				(0.07)			
R-squared	0.81				0.74			
LIK	-407.76				-414.65			

Notes: Standard errors in parentheses. *** (**) (*) Significant at 1% (5%) (10%). LIK: logarithm of maximum likelihood.

Source: Own elaboration.

TABLE 5. $S(W)$ MATRIX OF EFFECT ESTIMATES FOR THE GDP VARIABLE

	Andalucía	Aragón	Asturias	Baleares	Canarias	Cantabria	Castilla y León	Castilla-La Mancha	Cataluña	C. Valenciana	Extremadura	Galicia	Madrid	Murcia	Navarra	País Vasco	Rioja (La)	**Total spillovers**
Andalucía	1.9649	0.0175	0.0162	0.0123	0.0064	0.0173	0.0225	0.0351	0.0131	0.0214	0.0383	0.0152	0.0300	0.0292	0.0171	0.0174	0.0195	**0.3285**
Aragón	0.0175	1.9671	0.0179	0.0231	0.0049	0.0265	0.0243	0.0318	0.0412	0.0433	0.0168	0.0137	0.0304	0.0265	0.0608	0.0396	0.0479	**0.4662**
Asturias	0.0162	0.0179	1.9658	0.0103	0.0053	0.0465	0.0467	0.0209	0.0130	0.0151	0.0230	0.0447	0.0270	0.0144	0.0230	0.0291	0.0276	**0.3808**
Baleares	0.0123	0.0231	0.0103	1.9642	0.0043	0.0128	0.0125	0.0165	0.0339	0.0264	0.0107	0.0087	0.0149	0.0199	0.0179	0.0155	0.0167	**0.2562**
Canarias	0.0064	0.0049	0.0053	0.0043	1.9630	0.0052	0.0056	0.0057	0.0043	0.0051	0.0064	0.0056	0.0057	0.0055	0.0050	0.0051	0.0053	**0.0855**
Cantabria	0.0173	0.0265	0.0465	0.0128	0.0052	1.9678	0.0564	0.0266	0.0174	0.0197	0.0216	0.0244	0.0357	0.0175	0.0402	0.0652	0.0539	**0.4870**
Castilla y León	0.0225	0.0243	0.0467	0.0125	0.0056	0.0564	1.9675	0.0345	0.0159	0.0207	0.0321	0.0285	0.0557	0.0199	0.0308	0.0390	0.0420	**0.4872**
Castilla-La Mancha	0.0351	0.0318	0.0209	0.0165	0.0057	0.0266	0.0345	1.9677	0.0195	0.0380	0.0298	0.0169	0.0773	0.0419	0.0298	0.0293	0.0361	**0.4896**
Cataluña	0.0131	0.0412	0.0130	0.0339	0.0043	0.0174	0.0159	0.0195	1.9649	0.0291	0.0122	0.0104	0.0185	0.0197	0.0291	0.0230	0.0244	**0.3247**
C. Valenciana	0.0214	0.0433	0.0151	0.0264	0.0051	0.0197	0.0207	0.0380	0.0291	1.9662	0.0175	0.0123	0.0290	0.0531	0.0286	0.0243	0.0287	**0.4124**
Extremadura	0.0383	0.0168	0.0230	0.0107	0.0064	0.0216	0.0321	0.0298	0.0122	0.0175	1.9651	0.0231	0.0339	0.0198	0.0180	0.0195	0.0213	**0.3440**
Galicia	0.0152	0.0137	0.0447	0.0087	0.0056	0.0244	0.0285	0.0169	0.0104	0.0123	0.0231	1.9646	0.0204	0.0123	0.0162	0.0189	0.0187	**0.2899**
Madrid	0.0300	0.0304	0.0270	0.0149	0.0057	0.0357	0.0557	0.0773	0.0185	0.0290	0.0339	0.0204	1.9683	0.0288	0.0334	0.0360	0.0451	**0.5221**
Murcia	0.0292	0.0265	0.0144	0.0199	0.0055	0.0175	0.0199	0.0419	0.0197	0.0531	0.0198	0.0123	0.0288	1.9656	0.0216	0.0199	0.0231	**0.3733**
Navarra	0.0171	0.0608	0.0230	0.0179	0.0050	0.0402	0.0308	0.0298	0.0291	0.0286	0.0180	0.0162	0.0334	0.0216	1.9704	0.0883	0.0957	**0.5555**
País Vasco	0.0174	0.0396	0.0291	0.0155	0.0051	0.0652	0.0390	0.0293	0.0230	0.0243	0.0195	0.0189	0.0360	0.0199	0.0883	1.9718	0.1163	**0.5866**
Rioja (La)	0.0195	0.0479	0.0276	0.0167	0.0053	0.0539	0.0420	0.0361	0.0244	0.0287	0.0213	0.0187	0.0451	0.0231	0.0957	0.1163	1.9725	**0.6223**

Notes: Results obtained with the inverse distance matrix, normalised by its largest eigenvalue. The cells of the main diagonal are shaded.
Source: Own elaboration.

TABLE 6. $S(W)$ MATRIX OF EFFECT ESTIMATES FOR THE WAGE VARIABLE

	Andalucía	Aragón	Asturias	Baleares	Canarias	Cantabria	Castilla y León	Castilla-La Mancha	Cataluña	C. Valenciana	Extremadura	Galicia	Madrid	Murcia	Navarra	País Vasco	Rioja (La)	**Total spillovers**
Andalucía	-5.1475	-0.1181	-0.1092	-0.0828	-0.0431	-0.1167	-0.1514	-0.2359	-0.0879	-0.1438	-0.2576	-0.1023	-0.2021	-0.1966	-0.1151	-0.1171	-0.1310	**-2.2107**
Aragón	-0.1181	-5.1625	-0.1207	-0.1552	-0.0329	-0.1786	-0.1637	-0.2137	-0.2770	-0.2915	-0.1129	-0.0919	-0.2049	-0.1787	-0.4094	-0.2668	-0.3222	**-3.1382**
Asturias	-0.1092	-0.1207	-5.1538	-0.0692	-0.0358	-0.3132	-0.3143	-0.1407	-0.0873	-0.1015	-0.1548	-0.3006	-0.1819	-0.0969	-0.1547	-0.1960	-0.1860	**-2.5628**
Baleares	-0.0828	-0.1552	-0.0692	-5.1425	-0.0288	-0.0862	-0.0845	-0.1108	-0.2284	-0.1775	-0.0723	-0.0583	-0.1000	-0.1340	-0.1202	-0.1043	-0.1121	**-1.7245**
Canarias	-0.0431	-0.0329	-0.0358	-0.0288	-5.1349	-0.0349	-0.0378	-0.0385	-0.0292	-0.0344	-0.0430	-0.0378	-0.0385	-0.0369	-0.0336	-0.0345	-0.0356	**-0.5753**
Cantabria	-0.1167	-0.1786	-0.3132	-0.0862	-0.0349	-5.1670	-0.3794	-0.1792	-0.1171	-0.1325	-0.1454	-0.1640	-0.2404	-0.1180	-0.2706	-0.4386	-0.3631	**-3.2781**
Castilla y León	-0.1514	-0.1637	-0.3143	-0.0845	-0.0378	-0.3794	-5.1649	-0.2319	-0.1073	-0.1395	-0.2162	-0.1916	-0.3752	-0.1341	-0.2076	-0.2624	-0.2824	**-3.2793**
Castilla-La Mancha	-0.2359	-0.2137	-0.1407	-0.1108	-0.0385	-0.1792	-0.2319	-5.1661	-0.1311	-0.2561	-0.2004	-0.1136	-0.5205	-0.2822	-0.2005	-0.1969	-0.2432	**-3.2952**
Cataluña	-0.0879	-0.2770	-0.0873	-0.2284	-0.0292	-0.1171	-0.1073	-0.1311	-5.1477	-0.1962	-0.0821	-0.0699	-0.1243	-0.1324	-0.1957	-0.1548	-0.1645	**-2.1853**
C. Valenciana	-0.1438	-0.2915	-0.1015	-0.1775	-0.0344	-0.1325	-0.1395	-0.2561	-0.1962	-5.1560	-0.1177	-0.0830	-0.1955	-0.3577	-0.1925	-0.1637	-0.1930	**-2.7760**
Extremadura	-0.2576	-0.1129	-0.1548	-0.0723	-0.0430	-0.1454	-0.2162	-0.2004	-0.0821	-0.1177	-5.1486	-0.1556	-0.2283	-0.1335	-0.1210	-0.1314	-0.1432	**-2.3154**
Galicia	-0.1023	-0.0919	-0.3006	-0.0583	-0.0378	-0.1640	-0.1916	-0.1136	-0.0699	-0.0830	-0.1556	-5.1453	-0.1375	-0.0829	-0.1090	-0.1274	-0.1259	**-1.9513**
Madrid	-0.2021	-0.2049	-0.1819	-0.1000	-0.0385	-0.2404	-0.3752	-0.5205	-0.1243	-0.1955	-0.2283	-0.1375	-5.1704	-0.1940	-0.2246	-0.2426	-0.3037	**-3.5140**
Murcia	-0.1966	-0.1787	-0.0969	-0.1340	-0.0369	-0.1180	-0.1341	-0.2822	-0.1324	-0.3577	-0.1335	-0.0829	-0.1940	-5.1524	-0.1454	-0.1342	-0.1552	**-2.5127**
Navarra	-0.1151	-0.4094	-0.1547	-0.1202	-0.0336	-0.2706	-0.2076	-0.2005	-0.1957	-0.1925	-0.1210	-0.1090	-0.2246	-0.1454	-5.1842	-0.5946	-0.6444	**-3.7390**
País Vasco	-0.1171	-0.2668	-0.1960	-0.1043	-0.0345	-0.4386	-0.2624	-0.1969	-0.1548	-0.1637	-0.1314	-0.1274	-0.2426	-0.1342	-0.5946	-5.1938	-0.7829	**-3.9481**
Rioja (La)	-0.1310	-0.3222	-0.1860	-0.1121	-0.0356	-0.3631	-0.2824	-0.2432	-0.1645	-0.1930	-0.1432	-0.1259	-0.3037	-0.1552	-0.6444	-0.7829	-5.1984	**-4.1884**

Notes: Results obtained with the inverse distance matrix, normalised by its largest eigenvalue. The cells of the main diagonal are shaded.
Source: Own elaboration.

TABLE 7. $S(W)$ MATRIX OF EFFECT ESTIMATES FOR THE HC VARIABLE

	Andalucía	Aragón	Asturias	Baleares	Canarias	Cantabria	Castilla y León	Castilla-La Mancha	Cataluña	C. Valenciana	Extremadura	Galicia	Madrid	Murcia	Navarra	País Vasco	Rioja (La)	**Total spillovers**
Andalucía	0.1354	-0.0073	-0.0067	-0.0051	-0.0027	-0.0072	-0.0093	-0.0145	-0.0054	-0.0089	-0.0159	-0.0063	-0.0124	-0.0121	-0.0071	-0.0072	-0.0081	**-0.1361**
Aragón	-0.0073	0.1344	-0.0074	-0.0096	-0.0020	-0.0110	-0.0101	-0.0132	-0.0171	-0.0179	-0.0070	-0.0057	-0.0126	-0.0110	-0.0252	-0.0164	-0.0198	**-0.1932**
Asturias	-0.0067	-0.0074	0.1350	-0.0043	-0.0022	-0.0193	-0.0194	-0.0087	-0.0054	-0.0062	-0.0095	-0.0185	-0.0112	-0.0060	-0.0095	-0.0121	-0.0115	**-0.1578**
Baleares	-0.0051	-0.0096	-0.0043	0.1357	-0.0018	-0.0053	-0.0052	-0.0068	-0.0141	-0.0109	-0.0045	-0.0036	-0.0062	-0.0083	-0.0074	-0.0064	-0.0069	**-0.1062**
Canarias	-0.0027	-0.0020	-0.0022	-0.0018	0.1361	-0.0021	-0.0023	-0.0024	-0.0018	-0.0021	-0.0027	-0.0023	-0.0024	-0.0023	-0.0021	-0.0021	-0.0022	**-0.0354**
Cantabria	-0.0072	-0.0110	-0.0193	-0.0053	-0.0021	0.1341	-0.0234	-0.0110	-0.0072	-0.0082	-0.0090	-0.0101	-0.0148	-0.0073	-0.0167	-0.0270	-0.0224	**-0.2019**
Castilla y León	-0.0093	-0.0101	-0.0194	-0.0052	-0.0023	-0.0234	0.1343	-0.0143	-0.0066	-0.0086	-0.0133	-0.0118	-0.0231	-0.0083	-0.0128	-0.0162	-0.0174	**-0.2019**
Castilla-La Mancha	-0.0145	-0.0132	-0.0087	-0.0068	-0.0024	-0.0110	-0.0143	0.1342	-0.0081	-0.0158	-0.0123	-0.0070	-0.0321	-0.0174	-0.0123	-0.0121	-0.0150	**-0.2029**
Cataluña	-0.0054	-0.0171	-0.0054	-0.0141	-0.0018	-0.0072	-0.0066	-0.0081	0.1353	-0.0121	-0.0051	-0.0043	-0.0077	-0.0082	-0.0120	-0.0095	-0.0101	**-0.1346**
C. Valenciana	-0.0089	-0.0179	-0.0062	-0.0109	-0.0021	-0.0082	-0.0086	-0.0158	-0.0121	0.1348	-0.0072	-0.0051	-0.0120	-0.0220	-0.0119	-0.0101	-0.0119	**-0.1709**
Extremadura	-0.0159	-0.0070	-0.0095	-0.0045	-0.0027	-0.0090	-0.0133	-0.0123	-0.0051	-0.0072	0.1353	-0.0096	-0.0141	-0.0082	-0.0074	-0.0081	-0.0088	**-0.1426**
Galicia	-0.0063	-0.0057	-0.0185	-0.0036	-0.0023	-0.0101	-0.0118	-0.0070	-0.0043	-0.0051	-0.0096	0.1355	-0.0085	-0.0051	-0.0067	-0.0078	-0.0078	**-0.1202**
Madrid	-0.0124	-0.0126	-0.0112	-0.0062	-0.0024	-0.0148	-0.0231	-0.0321	-0.0077	-0.0120	-0.0141	-0.0085	0.1339	-0.0119	-0.0138	-0.0149	-0.0187	**-0.2164**
Murcia	-0.0121	-0.0110	-0.0060	-0.0083	-0.0023	-0.0073	-0.0083	-0.0174	-0.0082	-0.0220	-0.0082	-0.0051	-0.0119	0.1351	-0.0090	-0.0083	-0.0096	**-0.1547**
Navarra	-0.0071	-0.0252	-0.0095	-0.0074	-0.0021	-0.0167	-0.0128	-0.0123	-0.0120	-0.0119	-0.0074	-0.0067	-0.0138	-0.0090	0.1331	-0.0366	-0.0397	**-0.2302**
País Vasco	-0.0072	-0.0164	-0.0121	-0.0064	-0.0021	-0.0270	-0.0162	-0.0121	-0.0095	-0.0101	-0.0081	-0.0078	-0.0149	-0.0083	-0.0366	0.1325	-0.0482	**-0.2431**
Rioja (La)	-0.0081	-0.0198	-0.0115	-0.0069	-0.0022	-0.0224	-0.0174	-0.0150	-0.0101	-0.0119	-0.0088	-0.0078	-0.0187	-0.0096	-0.0397	-0.0482	0.1322	**-0.2579**

Notes: Results obtained with the inverse distance matrix, normalised by its largest eigenvalue. The cells of the main diagonal are shaded.
Source: Own elaboration.

TABLE 8. $S(W)$ MATRIX OF EFFECT ESTIMATES FOR THE INFR VARIABLE

	Andalucía	Aragón	Asturias	Baleares	Canarias	Cantabria	Castilla y León	Castilla-La Mancha	Cataluña	C. Valenciana	Extremadura	Galicia	Madrid	Murcia	Navarra	País Vasco	Rioja (La)	**Total spillovers**
Andalucía	1.4720	0.1436	0.1328	0.1007	0.0524	0.1420	0.1841	0.2869	0.1069	0.1749	0.3133	0.1244	0.2457	0.2392	0.1400	0.1424	0.1593	**2.6887**
Aragón	0.1436	1.4902	0.1468	0.1887	0.0401	0.2173	0.1991	0.2599	0.3369	0.3545	0.1373	0.1118	0.2492	0.2173	0.4978	0.3245	0.3919	**3.8166**
Asturias	0.1328	0.1468	1.4796	0.0841	0.0435	0.3809	0.3823	0.1711	0.1062	0.1234	0.1882	0.3655	0.2212	0.1179	0.1881	0.2383	0.2263	**3.1168**
Baleares	0.1007	0.1887	0.0841	1.4658	0.0350	0.1048	0.1027	0.1347	0.2778	0.2159	0.0880	0.0709	0.1216	0.1630	0.1462	0.1269	0.1363	**2.0973**
Canarias	0.0524	0.0401	0.0435	0.0350	1.4566	0.0424	0.0459	0.0468	0.0355	0.0419	0.0523	0.0460	0.0469	0.0449	0.0409	0.0419	0.0432	**0.6997**
Cantabria	0.1420	0.2173	0.3809	0.1048	0.0424	1.4957	0.4614	0.2180	0.1425	0.1611	0.1768	0.1995	0.2924	0.1435	0.3291	0.5334	0.4416	**3.9867**
Castilla y León	0.1841	0.1991	0.3823	0.1027	0.0459	0.4614	1.4931	0.2820	0.1305	0.1697	0.2629	0.2330	0.4564	0.1631	0.2525	0.3191	0.3434	**3.9883**
Castilla-La Mancha	0.2869	0.2599	0.1711	0.1347	0.0468	0.2180	0.2820	1.4946	0.1594	0.3114	0.2438	0.1382	0.6330	0.3432	0.2439	0.2395	0.2958	**4.0076**
Cataluña	0.1069	0.3369	0.1062	0.2778	0.0355	0.1425	0.1305	0.1594	1.4722	0.2386	0.0999	0.0850	0.1512	0.1610	0.2380	0.1882	0.2001	**2.6577**
C. Valenciana	0.1749	0.3545	0.1234	0.2159	0.0419	0.1611	0.1697	0.3114	0.2386	1.4822	0.1431	0.1009	0.2378	0.4350	0.2341	0.1991	0.2347	**3.3762**
Extremadura	0.3133	0.1373	0.1882	0.0880	0.0523	0.1768	0.2629	0.2438	0.0999	0.1431	1.4733	0.1892	0.2776	0.1624	0.1471	0.1598	0.1742	**2.8159**
Galicia	0.1244	0.1118	0.3655	0.0709	0.0460	0.1995	0.2330	0.1382	0.0850	0.1009	0.1892	1.4693	0.1673	0.1008	0.1326	0.1549	0.1532	**2.3731**
Madrid	0.2457	0.2492	0.2212	0.1216	0.0469	0.2924	0.4564	0.6330	0.1512	0.2378	0.2776	0.1673	1.4998	0.2359	0.2732	0.2950	0.3693	**4.2736**
Murcia	0.2392	0.2173	0.1179	0.1630	0.0449	0.1435	0.1631	0.3432	0.1610	0.4350	0.1624	0.1008	0.2359	1.4779	0.1768	0.1632	0.1887	**3.0559**
Navarra	0.1400	0.4978	0.1881	0.1462	0.0409	0.3291	0.2525	0.2439	0.2380	0.2341	0.1471	0.1326	0.2732	0.1768	1.5165	0.7232	0.7837	**4.5473**
País Vasco	0.1424	0.3245	0.2383	0.1269	0.0419	0.5334	0.3191	0.2395	0.1882	0.1991	0.1598	0.1549	0.2950	0.1632	0.7232	1.5283	0.9522	**4.8017**
Rioja (La)	0.1593	0.3919	0.2263	0.1363	0.0432	0.4416	0.3434	0.2958	0.2001	0.2347	0.1742	0.1532	0.3693	0.1887	0.7837	0.9522	1.5339	**5.0939**

Notes: Results obtained with the inverse distance matrix, normalised by its largest eigenvalue. The cells of the main diagonal are shaded.
Source: Own elaboration