A spatial approach to the FDI-growth nexus in Spain: Dealing with the headquarters effect

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Abstract:

This paper examines the effects of inward FDI on economic growth across the Spanish regions over the period 1996–2013, paying particular attention to the 'headquarters effect', namely that FDI is not always registered where it is effectively made but in the region in which the firm's headquarters is located. By estimating a panel Spatial Durbin Model to allow for the detection of spatial spillovers, two main findings are reported. First, FDI does foster economic growth. Second, only when the headquarters effect is properly addressed do spatial spillovers arise. Hence, this effect is masking the impact of regional FDI spillovers on growth, which affects the reliability of the results and, consequently, FDI policies choice. Importantly, the results are: a) robust to the way of computing the headquarters effect; b) independent of the spatial weight matrix specification; and c) confirmed when splitting FDI into different industrial and service branches.

Keywords: Foreign direct investment, growth, headquarters effect, spatial dependence, Spanish regions

JEL codes: C23, F21, O11, R12

1. Introduction

The nexus between FDI and economic growth has been extensively studied at both theoretical and empirical levels. From a theoretical perspective, the neoclassical growth model shows that FDI enhances growth just through increases in investment (Solow, 1956; Swan, 1956), whereas in the endogenous growth models it happens via knowledge and technology diffusion (Romer, 1986; Lucas, 1988). From the empirical perspective, there is such a vast literature that it is nearly impossible to acknowledge all the researchers that have been dealing with this issue. As a short reference to some recent surveys, see Ozturk (2007) and Clark, Highfill, Campino, and Rehman (2011). The main conclusion from this literature, in which most papers adopt countries as units of analysis, is that FDI tends to act as a growth driver among other reasons because of the existence of positive spillovers between foreign and domestic firms within the host country. This literature does not pay any heed, however, to spillovers among countries.

As said, the bulk of the literature adopts a country approach regarding the nexus between FDI and growth. This being the case, we agree with Beugelsdijk and Mudambi (2013) when they stress that a serious weakness of this brand of research stems from the use of countries as units of analysis, as they are much more different and heterogeneous than regions or cities. Needless to say, a regional approach is much more informative than a country one. However, it is also true that there are, at least, two important problems when the focus shifts from a national to a regional perspective: on the one hand, the presence of spatial spillovers, namely those happening between territories rather than within the one hosting FDI, cannot be overlooked; on the other hand is data quality assessment.

As for the first problem, it is important to note that traditional approaches treat territories (mostly countries) as "isolated islands" —i.e. independent units— disregarding the impact of what is happening elsewhere on the economic performance of a location. By doing this, they neglect the presence of spatial spillovers, which is perhaps not such a serious drawback when employing a country level approach, but no doubt becomes instrumental when the analysis takes a regional perspective. As stated by Capello (2009), this is so because the dynamics of one region influences the growth of others; in other words, the role played by spatial spillovers may be very relevant and must, therefore, be incorporated into the analysis. To the best of our knowledge, however, there are just a few recent papers dealing with this issue, all of them (apart from the first one) devoted to the Chinese case: Driffield (2006), Madariaga and Poncet (2007), Wen (2014), Mitze and Özyurt (2014), and Ma and Jia (2015). With different nuances, these papers tend to confirm a positive effect of FDI on growth as well as the existence of spatial spillovers between neighboring regions; in other words, they conclude that FDI in location *i* not only affects its economic performance but also does in nearby locations other than *i*. Several reasons, in line with the New Economic Geography literature, can be put forward to understand this somewhat expected result. For instance, Krugman's (1991) notion of the core-periphery system and its agglomerative implications can be applied at the regional level so that there will likely be agglomerations of FDI; this would lead to higher FDI levels in nearby regions and boost economic growth in this area. Another factor increasing FDI agglomeration lies in the fact that FDI may raise some regions' resource costs, such as wages, which makes neighboring regions more attractive (see e.g., Blanc-Brude, Cookson, Piesse & Strange, 2014).

In view of this, the theoretical contribution of this paper lies on the inclusion of these interdependencies in the growth model, trying to explain why the growth rate of a region depends not only on its specific factors, FDI among them, but also on the same factors and the global economic performance in the remaining ones. To do so, since growth spillovers are expected to be stronger among neighboring regions, in the proposed model we assume—through the definition of geographical distance matrices as we will see below—that the closer the alternative territory is, the greater its impact will be. There are, in fact, several reasons for the spatially bounded nature of spillovers, such as “reduced transport costs and easier commuting possibilities for the labor force” (Capello, 2009: 644).

But the need to include spatial interactions in the model is not the only issue you have to cope with when adopting a regional approach. As mentioned, there is a second important problem, now of statistical nature, which so far has been fully ignored in the literature: this refers to the presence of what we coin as the ‘headquarters effect’. It pertains to the fact that, as a rule, FDI tends to be registered in the region in which the headquarters of the subsidiary firm is located rather than in the place where the bulk of the investment is really made, so data tend to support an ‘artificial’ concentration of FDI in certain (mostly capital) regions that most likely do not exist. This is especially so—FDI data is not collected where it occurs—when the FDI is made for productive motives, while for other activities (R&D, sales or service activities) investment tends to be more likely allocated to the subsidiary where the headquarters is located.

Consequently, the headquarters effect is, like any other case of poor data collection, an important, although completely overlooked, problem in need of a solution. In our view, it has to be addressed beforehand since, otherwise, it might seriously affect the reliability of the results regarding the link between FDI and growth and, therefore, the validity of the policies based on them. For that reason, this paper also tries to contribute to the literature in addressing the headquarters effect. Specifically, the paper proposes a way of estimating this effect and, in so doing, provides a set of new FDI data free from it to test an important hypothesis: whether neglecting (disregarding) the headquarters effect severely underrates the spatial spillovers of FDI on economic growth or not. We want to stress that testing this hypothesis becomes instrumental from a policy point of view. If it were confirmed, a straightforward policy conclusion would be that the generally accepted idea of implementing specific regional policies is not the best option, or even worse that this kind of policies is doomed to fail. Accordingly, joint policies to get the most from spatial spillovers would be welcome.

In summary, this paper takes a regional approach to study the link FDI-growth and, on the one hand, includes spatial interactions in the FDI-growth model and, on the other, deals with the headquarters effect. When addressing these two issues, for which we use Spain as a sort of laboratory as detailed in Section 2, the paper also attempts to enrich the FDI-growth literature from a methodological point of view. In contrast to previous studies on the topic and in line with the model proposed, it focuses on modeling spatial spillovers arising not only from the dependent variable (growth) but also from FDI and the remaining independent variables, for which it estimates a full Spatial Durbin Model (SDM). Furthermore, it computes partial derivatives to obtain more accurate estimates of the impact of FDI (and other independent variables) on growth, which means that it also estimates the so-called average direct, indirect and total effects (LeSage & Pace, 2009). We admit that the present paper is not unique in this respect, but as far as we know, Mitze and Özyurt's (2014) is the only paper that looks at partial derivatives. Anyway, our paper moves a step forward in the direction of computing the direct and indirect effects for each pair of regions and shows them in a matrix form. Therefore, this is the first paper to conduct a profound analysis of this issue; by doing this, it offers more insights about how FDI affects growth.

The remainder of the paper is organized as follows. Section 2 presents FDI data. Section 3 specifies the benchmark growth model and estimates it by employing raw FDI data. Section 4 addresses the computation of the headquarters effect and estimates the model by using FDI data free from that effect; additionally, it takes a step forward by computing the matrix of effect estimates. Section 5 presents some robustness tests by using a) an alternative computation of the headquarters effect, b) different spatial weight matrices and c) FDI data at the sectoral level. Finally, Section 6 offers the main conclusions.

2. FDI Data

As mentioned in the Introduction, this paper adopts a regional approach by taking Spain as a case study. It carries out the analysis at the regional level since it is the finest disaggregation possible; no homogeneous, long series FDI data exist for the Spanish provinces (NUTS-3), let alone for cities. More specifically, the paper uses data collected for the Spanish regions (NUTS-2) over the period 1996–2013. As for the sample period, 1996 is the first year for which homogeneous data are available. On the other side, we decided to end the analysis in 2013 because it is the final year of the recession in Spain; we believe the new "boom" period is too short and so different from the previous ones that it is better not to include it in the analysis.

There are two main reasons why we choose Spain as our case study. First, this country has been a highly attractive destination for FDI since, at least, the mid-eighties (Bajo-Rubio & López-Pueyo, 2002) and, what is even more important, has experienced a growth process differentiated at the regional level. Second, although relatively long and detailed series on FDI at the regional level are available, there are not many studies investigating the effect of FDI on growth in Spain. The most relevant ones are Bajo-Rubio and Sosvilla-Rivero (1992; 1994) and Bajo-Rubio, Díaz-Mora and Díaz-Roldán (2010), but none of them dealt with the presence of spatial dependence.

To provide some initial key insights into the case study, Table 1 displays the distribution of inward FDI flows (obtained from the Spanish Foreign Investment Registry [DataInvex]) across Spanish regions (at both aggregate and sectoral levels) over the sample period. First, data show that FDI is highly concentrated in just two regions. Madrid and Cataluña received, on average, about 80% of total FDI, although Madrid got more than four times the amount of Cataluña; as the capital of Spain is located in the region of Madrid, it seems there is little doubt about the existence and relevance of the headquarters effect. It is also important to stress that this circumstance is not unique to Spain but takes place, at least, in most European countries, which reinforces the relevance of the topic we are concerned with. Some hints about the existence of the headquarters effect in other European countries can be found in Villaverde and Maza (2015) and Maza and Villaverde (2015). A second important point emerging from Table 1 is that FDI inflows are highly volatile in all regions, particularly in Aragón, Murcia and Asturias (see coefficient of variation [CV] figures). As for sectors, Table 1 shows that FDI sectoral distribution across regions is very heterogeneous but mainly concentrated in industry and services. On average, more than 80% (60%) of the inward FDI received by Asturias, Extremadura and Murcia (Baleares, Madrid and Castilla-León) goes to the industrial (service) sector. All these preliminary insights spark our interest in specific issues we will cope with throughout the paper and help the reader realize how appealing our topic and case study are.

INSERT TABLE 1 AROUND HERE

3. FDI and growth: Model specification and results

3.1. Model specification

As mentioned in the Introduction, when dealing with the link FDI-growth at the regional level, a spatial model has to be proposed. Regarding this point, sound theoretical reasons support the use of an SDM in the specification of a spatial growth model (see LeSage & Fischer, 2008) so that it is our baseline model. With regard to the independent variables, apart from considering FDI, we include a set of control variables comprising those more often used as potential determinants of growth in the standard literature.[1] Specifically, we estimate the following SDM to analyze the impact of FDI on economic growth:

$$\Delta Y_{it} = \rho \sum_j w_{ij}\ \Delta Y_{jt} + \beta\, Y_{it-1} + \theta \sum_j w_{ij}\, Y_{jt-1} + \sigma_1\, FDI_{it-1} + \sigma_2 \sum_j w_{ij}\, FDI_{jt-1} +$$
$$\gamma_1\, I_{it-1} + \gamma_2 \sum_j w_{ij}\, I_{jt-1} + \vartheta_1\, TO_{it-1} + \vartheta_2 \sum_j w_{ij}\, TO_{jt-1} + \emptyset_1\, HC_{it-1} +$$
$$\emptyset_2 \sum_j w_{ij}\, HC_{jt-1} + \delta_1\, Agr_{it-1} + \delta_2 \sum_j w_{ij}\, Agr_{jt-1} + \lambda_1\, Ind_{it-1} + \lambda_2 \sum_j w_{ij}\, Ind_{jt-1} +$$
$$\varphi_1\, Ser_{it-1} + \varphi_2 \sum_j w_{ij}\, Ser_{jt-1} + \pi\, d_{crisis} + \mu_i + u_{it} \qquad (1)$$

where the dependent variable is the growth rate of per capita GDP in region i at year t (ΔY_{it}), expressed in thousand euros of 2000 and proxied by the first difference of log-levels; GDP and population (as well as the Consumer Price Index used to deflate nominal values) are extracted from the Spanish National Statistics Institute. As for the independent variables, we include a battery of them, as well as their spatial lags and the spatial lag of the dependent variable. The list of independent variables is as follows:

Y_{it-1}. Following the standard β-convergence analysis (Mankiw, Romer, & Weil, 1992; Barro & Sala-i-Martin, 1992), we include per capita GDP in the previous year. We expect a negative relationship between ΔY_{it} and Y_{it-1}.

FDI_{it-1}. As we aim to analyze the impact of FDI on growth, we enlarge the neoclassical model by introducing FDI (lagged one period) as the independent variable (Ma & Jia, 2015). The use of lagged data helps tackle potential endogeneity concerns. Our FDI variable is computed as the accumulated flows[2] of inward gross FDI as a percentage of GDP. Data on FDI flows come

[1] Although institutional factors are quite relevant when explaining FDI-growth nexus (see e.g. Ketteni, & Kottaridi, 2019) they are rather similar across regions in Spain, so we opted for not including any.

[2] We follow Bajo-Rubio et al. (2010, p. 377), who claimed that '*a stock, rather than a flow, measure of FDI should be used in order to capture the permanent character of FDI rather than the fluctuations associated with*

from the Spanish Foreign Investment Registry (DataInvex). Finally, regarding the sign of the coefficient linked to this variable, we expect a significant and positive coefficient since FDI is considered as a relevant factor in boosting economic growth through technology transfer, employment and export promotion, capital accumulation and human capital improvement (de Mello, 1997).

I_{it-1}. Starting with control variables, another key determinant of economic growth is investment/capital formation (see e.g. Barro, 2003). This variable is defined as gross investment over GDP. Data come from the Valencian Institute of Economic Research (IVIE). We expect a positive relationship between ΔY_{it} and I_{it-1}.

TO_{it-1}. Both endogenous growth-models and extended neoclassical growth models bring up the idea that the relationship between trade openness and economic growth is far from being resolved. Although, in principle, openness boosts economic growth, it may also adversely affect it (for some references on this issue, see Yanikkaya, 2003). Accordingly, there is no expected sign for the coefficient linked to this variable. In the same vein, there is no consensus as to what trade openness means and how to measure it. Here we include a trade volume variable, which is defined as the sum of exports plus imports, with OECD countries, over GDP. Two main reasons support this choice. On the one hand, avoiding multicollinearity problems as the correlation coefficient between FDI and trade openness with OECD countries is much lower than when trade openness is computed using total trade. On the other hand, it is usually argued that trade is more profitable for countries trading with technologically innovative countries (Yanikkaya, 2003). Data for exports and imports are collected from the Ministry of Economics and Finance (DataComex).

flows'. As in Bajo-Rubio et al.'s paper, and because data on FDI stock for each year are not available, we proxy it by using the accumulated sum of gross FDI inflows from 1995 to that particular year.

HC_{it-1}. The role of education as an important driver for economic growth has been extensively acknowledged (see e.g. Barro, 2001). Therefore, we include a human capital variable, computed with data of the employed population by their educational attainment (obtained from IVIE) and defined as the share of the active population with some tertiary education. A positive sign is expected for the corresponding coefficient.

Agr_{it-1}, Ind_{it-1} and Ser_{it-1}. To take into account industry-mix differences between Spanish regions, we add the shares of agriculture, industry and the service sector in the previous year as control variables; the construction sector is left aside to avoid multicollinearity problems. These variables are computed as the percentage of employment in each sector over total employment (taken from Cambridge Econometrics). A positive (negative) sign is expected in the case of industry and services (agriculture).

d_{crisis}. A dummy variable, capturing the crisis period and taking on a value of 1 from 2008 onward and 0 otherwise. A negative sign is expected due to the adverse effect of the economic crisis on growth.

μ_i. Regional fixed effects (supported by the Hausman test results).

It is worth noting that all the independent variables, except the dummy, are expressed in logs. To compute the corresponding spatial lags, we multiply each variable by the elements (w_{ij}) of the spatial weight (so-called distance) matrix W. This matrix, as it is well-known, is the gauge we use for weighing the influence of variables at the surrounding locations, so that, as indicated in the Introduction, this matrix gives more weight to nearby than to distant observations. Specifically, it is defined as the inverse of the shortest Euclidean distance in kilometers between centroids of the corresponding regions, and it is row-standardized for easier interpretation. Spatial lags capture, therefore, spatial interactions reflecting that per capita GDP growth in a region is affected not only by (lagged values of) per capita GDP, FDI, investment, trade openness, human capital, and sectoral structure in that region but also by these variables in nearby regions and neighboring growth experiences.

Once we have specified the model, and before presenting its results, it is pertinent to pause to clarify two important points. First, to stress that we tested whether our SDM could be simplified into a Spatial Autoregressive Model (SAR) or a Spatial Error Model (SEM) (Elhorst, 2014a). To do so, we estimated Equation (1) and computed the corresponding likelihood ratio (LR) tests for Spatial Autoregressive Model (SAR) and Spatial Error Model (SEM). The results, with statistics equal to 34.08 for the SAR and 23.69 for the SEM, in both cases with a p-value equal to 0.00, clearly tilt the scales in favor of the SDM.

Second, it is essential to keep in mind that the interpretation of the estimated coefficients in an SDM requires careful attention. The coefficients (point estimates) cannot be interpreted directly because according to a Leontief expansion of the inverse matrix, $(I_n - \rho W)^{-1} = I_n + \rho W + \rho^2 W^2 + \cdots$, they are no longer marginal effects. This is so since the feedback effects derived from the dependence relationship in the spatial lags complicate their interpretation. Therefore, point estimates have to be considered as a preliminary step that is needed to calculate, through the computation of the matrix of effect estimates, the so-called average direct, indirect (what we consider spatial spillovers) and total effects (LeSage & Pace, 2009). In our model, for instance, the *average direct effect* of FDI measures the average impact on the economic growth rate of a particular region caused by a change in FDI of that region. This means that, although for its own nature it does not capture spatial spillovers (between regions), it does capture all other effects (spillover and non-spillover effects) within a region. On the other hand, the *average indirect effect* or *spatial spillover*[3] reflects the cumulative average effect of the changes in FDI of neighboring regions on the growth rate of a specific region. The *average total effect* is the sum of both, the average direct and indirect effects.

3.2. Results

With these considerations in mind, we now present and discuss the results. The first column of Table 2 displays the point estimates of Equation (1), obtained by maximum likelihood. As stated above and to gain knowledge about the real effect of any variable on growth, we also report the average direct, indirect and total effects in the first panel of Table 3.

The spatial autoregressive parameter is positive and statistically significant ($\hat{\rho} = 0.709$), supporting the existence of important connections between regional growth experiences. In addition, the coefficient linked to per capita GDP is negative and statistically significant, indicating that there exists a process of conditional β convergence. This is confirmed by its statistically significant and negative direct effect. The annual speed of convergence (the rate at which regions approach their steady-state) is 7.14%, which leads to a half-life (time necessary to cover half the distance separating regions from their steady state assuming that the current convergence speed keeps over time) of 9.7 years. These two estimates were proxied by using the direct effect rather than the point estimate.

As regards the impact of FDI on growth, although the linked coefficient is not significant, the direct effect, once feedback effects previously mentioned are included, becomes positive and statistically significant; this result indicates that, as expected, FDI received in a particular region positively contributes to economic growth in that region. The spatial lag of FDI and

[3] Spatial spillovers produced by the SDM are global; that is, they include feedback effects arising because of impacts passing through neighboring regions and back to the region where the change originated from (Halleck Vega & Elhorst, 2015).

the indirect effect do not result statistically significant, however, which implies that there are no FDI spatial spillovers. We will delve into this issue later.

Concerning the influence of investment on income growth, all coefficients and effects turn out to be non-significant. In other words, higher investments do not result in more intense economic growth. Although this is a somewhat unexpected result, Blomstrom, Lipsey, and Zejan (1996, p. 275-276) note in a key paper on this issue that maybe '*economic growth induces subsequent capital formation more than capital formation induces subsequent growth*'; in fact, our result is in line with that obtained by other researchers such as Choe (2003), Yenturk, Ulengin, and Cimenoglu, (2009) and Crowder and de Jong (2011).

A similar situation occurs with regard to trade openness. Once again, neither coefficients nor effects are statistically significant. This finding is not, as mentioned above, so unusual. For instance, in papers by Krugman (1994) and Rodrik (1995), the effect of openness on growth is not that much significant and it may be, even, doubtful. Additionally, Rodriguez and Rodrik (2001) state that, when geographical variables are included (and we are estimating a spatial model, so this would be our case), trade openness does not keep significant in growth regressions.

Human capital, nevertheless, emerges as an engine of economic growth. Specifically, both the coefficient and the direct effect are positive and statistically significant, whereas the spatial lag and the indirect effect do not turn out to be significant. In other words, regions with a higher level of human capital tend to undergo higher economic growth; our findings, however, do not support the existence of spillover effects.

As for the industry-mix, direct and indirect effects indicate that higher economic growth in a specific region is expected if the weight of its industrial sector is relevant and, to a greater extent, it is surrounded by regions with large industrial and service sectors. Finally, it is also important to note that the dummy estimate confirms the negative impact that the crisis has had on per capita GDP growth.

INSERT TABLE 2 AROUND HERE

INSERT TABLE 3 AROUND HERE

4. Addressing the headquarters effect

After presenting the results with raw FDI data, the aim of this section is, as indicated in the Introduction, to conduct a test of the following hypothesis: FDI data are 'dirty' when the headquarters effect is not taken into account so that the indirect effect of FDI on economic growth is underrated. We begin by proposing a method to compute the headquarters effect and use it to calculate FDI data free from the effect. Then, we use the new data to re-estimate the growth model and compare the results obtained with those previously presented with raw data. Finally, and to gain more insights into the effect of FDI on growth and learn about the effects for each pair of regions, we compute the matrix of effect estimates associated with the FDI variable.

4.1. Computation of the headquarters effect

As pointed out previously, the so-called headquarters effect arises when the production site(s) and the headquarters of a company are located in different regions (let's say a and b, respectively) and FDI received by this company is recorded in region b. In the case of Spain, as reported, FDI is highly concentrated in Madrid: on average for the sample period and according to raw data, it receives 64% of total FDI flows. This exceptionally high share is partially due to the headquarters effect. Consequently, the remaining regions have less registered inward FDI than what they have received. This fact presents major statistical challenges for the researcher, as it might likely affect the reliability of the results obtained.

To address this issue, we proceed to estimate the headquarters effect and re-estimate Equation (1) once it has been removed. As for the first, we proceed in three steps: 1) We estimate a traditional model of FDI determinants, but with spatial effects as already highlighted in the literature (e.g. Blonigen, Davies, Waddell, & Naughton, 2007; Baltagi, Egger, & Pfaffermayr, 2007; Villaverde & Maza, 2012, 2015; Regelink & Elhorst, 2015; Castellani, Meliciani, & Mirra, 2016; Gutiérrez-Portilla, Maza, & Villaverde, 2018, 2019). In this model, we include a dummy for Madrid in an attempt to capture the inward flows of FDI registered in this region that are not explained by standard FDI determinants. In other words, we compute FDI flows that can be explained by factors idiosyncratic to Madrid, among which is the fact that the region is the site of the capital of the country so that the official headquarters of many international companies are located there. 2) By using the coefficient linked to the dummy, we approximate the headquarters effect. 3) We subtract from the raw FDI data of Madrid the amount corresponding to the headquarters effect and then redistribute it among the rest of the Spanish regions.

Accordingly, we start by estimating a spatial FDI model. Specifically, the following SAR model of FDI determinants,[4] whose results are reported in the first column of Table 4, is computed:

$$fdi_{it} = \beta_1 \sum_j w_{ij}\, fdi_{it} + \beta_2\, GDP_{it} + \beta_3\, EW_{it} + \beta_4\, RI_{it} + \beta_5\, d_{Madrid} + \theta_t + \varepsilon_{it} \qquad (2)$$

where fdi denotes FDI flows as a percentage of GDP; $\sum_j w_{ij}\, fdi_{jt}$ is the spatial lag of fdi; GDP is taken as a proxy for market size; EW denotes effective wages (or unit labor costs),

[4] A similar specification is used in Gutiérrez-Portilla, Maza, Villaverde, and Hierro (2016). There are two main differences. 1) The interaction variable between wages and human capital is replaced, following the suggestion by a referee, by a new variable denoting effective wages. 2) Our model takes into account spatial dependence.

defined, from data taken from Cambridge Econometrics, as the ratio between labor costs (remuneration per employee) and productivity (GDP per employee); RI is the endowment of road infrastructure, expressed in kilometers of motorways per 1000 km^2 (from Eurostat); d_{Madrid} is the dummy variable for Madrid; and, finally, θ_t are time fixed effects. Note that all variables, except the dummy, are expressed in logs.

INSERT TABLE 4 AROUND HERE

If we take a break here to comment briefly on the results, it is important to stress that the coefficient linked to the spatial lag variable confirms the existence of spatial spillovers. Additionally, it seems that market size is one of the main determinants of FDI as its coefficient results positive and statistically significant. As for effective wages, a positive coefficient conveys the idea, by applying Dunning's postulates, that FDI to Spanish regions is motivated by efficiency seeking products rather than efficiency seeking processes (Dunning, 1993). It seems, however, that the role of transport infrastructures is almost negligible. Finally, the estimated coefficient associated with the dummy is, as expected, positive and statistically significant.

The second step lies in using this coefficient to proxy for every year the amount of annual FDI inflows registered in Madrid due to the headquarters effect. Taking into consideration that the fdi variable is expressed in logs and in terms of GDP, we first apply the exponential function to the estimated coefficient of the dummy, and then, we multiply this result by the GDP of Madrid in each year. Although the headquarters effect changes every year, on average it accounts for 35.43% of the FDI registered in Madrid.

Next, we deduct from the annual FDI data of Madrid the percentage corresponding to the headquarters effect, so that we obtain the 'new' FDI data for Madrid free from this effect. Finally, we distribute these flows of FDI due to the headquarters effect among the remaining

Spanish regions. Given the undeniable connections between FDI and exports (the correlation, excluding Madrid, is 0.81), we do it, year by year, according to their corresponding shares on total (excluded Madrid) exports (data were collected from DataComex).

4.2. New results for the growth model

By using the new FDI data, Equation (1) is re-estimated as the SDM model continues being the preferred one once specification tests are re-computed. Point estimates and average direct, indirect and total effects are reported in the second column of Table 2 and the second panel of Table 3, respectively. The spatial autoregressive coefficient ($\hat{\rho} = 0.693$) points, once again, to the existence of significant connections among the various regional growth experiences. As for convergence, the negative and significant β coefficient and the direct effect associated with per capita GDP lagged one year reinforce that there has been a process of convergence across Spanish regions. The results for industry mix and the dummy crisis are also in line with those obtained in Section 3.

Remarkable differences arise, however, with regard to the effect of FDI on economic growth. With the new FDI data, there exists a positive and statistically significant spatial spillover associated with FDI (Table 3), which is five times higher than the direct effect. This finding indicates that Spanish regions took advantage not only of their own FDI but also of FDI received by neighboring regions. This is in accordance with the results found by Madariaga and Poncet (2007) for Chinese cities and Mitze and Özyurt (2014) for Chinese provinces. Our result is also in line with those obtained by Barrios, Bertinelli and Strobl (2005) although by using a different approach based on an entry model, for the Irish case. They conclude that MNEs can boost growth both within and in surrounding regions because FDI promotes, due to input-output linkages, the creation of new domestic firms.

It is worth mentioning that the difference between the point estimate (0.006) linked to the spatial lag of FDI ($\sum_j w_{ij}\, FDI_{jt-1}$) and the indirect effect (0.036) reveals the existence of positive feedback effects; these effects arise as a result of impacts passing through neighboring regions and coming back to the region they originated from. In other words, the hypothesis about the headquarters effect is confirmed: neglecting this effect implies that spatial spillovers of FDI on economic growth are underestimated.

4.3. Toward a deeper knowledge of feedback effects: matrix of effect estimates

To provide further insights into the impact of FDI on growth, we compute the matrix of effect estimates associated with FDI (Table 5). This matrix, which contains the responses of economic growth to FDI for each pair of regions, takes the following form in our SDM model (Equation 1):

$$S(W) = V(W) * (I_n \sigma_1 + W\sigma_2) \tag{3}$$

where $V(W)$ stands for the spatial multiplier:

$$V(W) = (I_n - \rho W)^{-1} \tag{4}$$

ρ being the spatial autoregressive coefficient, σ_1 and σ_2 the estimated coefficients of the FDI variable and its spatial lag, and I_n the identity matrix (of order 17*17 in this case). The main-diagonal elements of the matrix $S(W)$ are the own-partial derivatives and their average is the average direct effect, while its off-diagonal elements are the cross-partial derivatives, and by averaging their cumulative sum for each region, we obtain the average indirect effect.

INSERT TABLE 5 AROUND HERE

Two main conclusions can be drawn from the analysis of this matrix. On the one hand and as expected, the direct effect of FDI on growth in each region is always higher than any individual indirect effect. However, as previously seen, when the indirect effects are taken together, the resulting effect in each region plays a higher role than the direct one. On the other hand, the highest values of the individual indirect effects in each region tend to correspond to its nearest neighbors.

5. Robustness checks

Having shown that the FDI effectively received by regions (in other words, when data are free from the headquarters effect) promotes growth and that spatial spillovers are remarkable, we here check out the reliability of this finding from different perspectives. In all cases, and for the sake of simplicity, we only show average direct, indirect and total effects. The three robustness checks we conduct (plus an additional one, which is reported in the Appendix since it only implies a little change in the model that has to do with FDI lags), are as follows: first, from the standpoint of the location (and then magnitude) of the headquarters effect, by considering that it could come about not only in Madrid but also in Cataluña; second, with regards to the weighting method proposed, by employing alternative spatial weight matrices; and, third, concerning the data selection process, by considering FDI at sectoral rather than just at aggregate level.

5.1. Headquarters effect in Madrid and Cataluña

In line with the figures quoted in the Introduction, we address here the possibility that a significant number of foreign firms whose headquarters are located in Cataluña may also operate in other regions. For this reason, we estimate a new version of Equation (2), in which we include an additional dummy variable for Cataluña ($d_{Cataluña}$). The new equation, whose estimation results are reported in the second column of Table 4, reads as follows:

$$fdi_{it} = \beta_1 \sum_j w_{ij}\, fdi_{it} + \beta_2\, GDP_{it} + \beta_3\, EW_{it} + \beta_4\, RI_{it} + \beta_5\, d_{Madrid} + \beta_6\, d_{Cataluña} + \theta_t + \varepsilon_{it} \quad (5)$$

Then, we proceed as before. Using the estimated coefficients associated with the dummy variables for Madrid and Cataluña, we proxy for each year the amounts of annual FDI inflows that are registered in each of these regions due to the headquarters effect. Afterward, we deduct these amounts from the annual FDI data for Madrid and Cataluña to obtain the free FDI data for these two regions. Finally, the annual amounts of FDI inflows due to the headquarters effect in Madrid and Cataluña are distributed among the rest of the Spanish regions.

The results for the growth equation (third part of Table 3) are in line with those previously obtained, thus reinforcing the existence of remarkable positive spatial spillovers of FDI on economic growth when the case of Catalonia is also considered.

5.2. Alternative spatial weight matrices

Now, we change the perspective and focus our attention on the SDM (Equation 1). To avoid repetition, as we have seen that no significant differences depend on the inclusion or not of Cataluña when it comes to computing the headquarters effect, we henceforth we use the new FDI series obtained in Subsection 4.1 (only considering Madrid).

The specification of the weight/spatial matrix is a sensitive point in spatial econometric modeling since the choice of spatial weights can have a substantive impact on the results. For this reason, we replicate the previous estimations with two alternative spatial weight matrices. First, we change the definition of the matrix to the five-nearest neighbor spatial weight matrix; results were very similar when considering alternative numbers of neighbors. Second, we employ a different standardization technique: instead of a row-standardized inverse distance matrix, we normalize the inverse distance matrix by its largest eigenvalue (Kelejian & Prucha, 2010; Elhorst, 2014b).

Focusing our attention on FDI, the results obtained (Table 6) are again very much in line with the former estimates, thus confirming the positive effect of FDI on growth. As regards its decomposition into direct and indirect effects, the importance of FDI in neighboring regions outweighs (as a whole) that of FDI in a particular region in both cases; anyhow, it is worth mentioning that the relevance of spillovers is lower when using the five-nearest neighbor spatial weight matrix.

INSERT TABLE 6 AROUND HERE

5.3. Sectoral breakdown

The aim of this subsection is twofold: first, to determine whether the results obtained using aggregate FDI keep when disaggregated FDI data by sector are considered; and second, to add information on whether the growth impact of FDI differs across branches.

To do this, we take our growth model (Equation 1) and, following Alfaro (2003), disaggregate the independent FDI variable into different branches of the industry and service sectors, which together account for over 95% of total FDI. We use FDI in each branch (corrected by the headquarters effect[5]) as a percentage of GDP. The new specification is as follows:

$$\Delta Y_{it} = \rho \sum_j w_{ij}\ \Delta Y_{jt} + \beta\ Y_{it-1} + \theta \sum_j w_{ij}\ Y_{jt-1} + \sum_k \sigma_k\ FDI_{it-1}^{k} + \sum_k \sum_j \tau_k\ w_{ij}\ FDI_{jt-1}^{k} + \gamma_1\ I_{it-1} + \gamma_2 \sum_j w_{ij}\ I_{jt-1} + \vartheta_1\ TO_{it-1} + \vartheta_2 \sum_j w_{ij}\ TO_{jt-1} + \emptyset_1\ HC_{it-1} + \emptyset_2 \sum_j w_{ij}\ HC_{jt-1} + \delta_1\ Agr_{it-1} + \delta_2 \sum_j w_{ij}\ Agr_{jt-1} + \lambda_1\ Ind_{it-1} + \lambda_2 \sum_j w_{ij}\ Ind_{jt-1} + \varphi_1\ Ser_{it-1} + \varphi_2 \sum_j w_{ij}\ Ser_{jt-1} + \pi\ d_{crisis} + \mu_i + u_{it} \tag{6}$$

[5] Once the total headquarters effect is computed for each year of our sample period, we distribute it by using the percentage of each branch on total FDI received by Madrid. That is, if the headquarters effect were 100 in a given year and the share of a particular branch over total FDI in Madrid were 30%, the headquarters effect for this branch would be 30. This amount is then distributed across the remaining regions. For the case of the industry sector we use region-branch export data, but for services data on exports for the three branches of the sector are not available at the regional level, so we have to use region-branch FDI data.

where *k*=1,2 denotes the branches of industrial sector (*k*=1 for manufacturing, which accounts, on average during the sample period, for 60.4% of FDI in industry; and *k*=2 for mining, quarrying and energy supply, accounting for the remaining 39.6%), while *k*=3,4,5 refers to the branches of the service sector (*k*=3 for logistics, which receives on average 30.4% of FDI in services; *k*=4 for financial intermediation, accounting for 18.9%; and *k*=5 for distribution, accounting for 29.8%).

Based on a similar approach to Alfaro (2003), the sectoral analysis is carried out in three steps. First, we estimate Equation (6) including FDI for the industrial branches (*k*=1,2); then, we only include the branches for services (*k*=3,4,5); finally, we perform the same estimation including the five branches (*k*=1,2,3,4,5), so that potential interactions among them, which could affect the results, are properly addressed.

The first panel of Table 7 reports the results of estimating Equation (6) with FDI in two broad branches of the industrial sector. As can be seen, FDI received in manufacturing has a positive effect on growth and the spatial spillover effect prevails over the direct effect; in contrast, FDI in mining, quarrying and energy supply does not contribute to economic growth.[6]

INSERT TABLE 7 AROUND HERE

As for the service sector (second panel of Table 7), FDI in financial intermediation enhances economic growth, while that in logistics and distribution is not statistically significant. It is also worth highlighting that the spillover effect of FDI in financial intermediation is more than twice as high as the direct effect.

[6] Although in the paper by Orlic, Hashi, & Hisarciklilar (2018) the concept of spillover effect is different, as it refers to linkages between local and foreign companies rather than spatial spillovers, they conclude that local manufacturing firms benefit from the backward spillovers in manufacturing and forward spillover effects of FDI in services.

Finally, the third panel of Table 7 shows the results when considering all branches simultaneously. The results of sectoral FDI on growth also strengthen previous findings but with one important additional insight: the role of services and industry branches changes significantly; they are now higher in the former (now, in fact, the distribution branch coefficient (k=5) becomes significant) and smaller in the latter.

6. Conclusions

By adopting a regional approach and taking Spain as a sort of laboratory, the paper examines the impact of inward FDI on economic growth over the period 1996–2013. To the best of our knowledge, this is the first paper addressing the so-called headquarters effect; that is, the fact that FDI data collection in Spain is biased in favor of the capital region (Madrid). In this respect, it proposes a method to compute this effect and obtain new FDI data free from it. Additionally, it makes a theoretical contribution in that it uses a spatial growth model that stresses the income growth rate of a region depends not only on its specific features but also on those of the neighboring ones. Related to this, the paper also offers a contribution of methodological nature in different respects. First, unlike previous papers considering only endogenous interaction effects, a panel Spatial Durbin Model is estimated. Second, it computes average direct, indirect and total effects to obtain more accurate results. Third, it goes one step further and computes the matrix of effect estimates associated with FDI to examine direct and indirect effects for each pair of regions.

In any case, for the sake of comparison and to reveal the importance of the issue at hand, the paper initially estimates the proposed panel SDM with raw FDI data. The results show a positive direct effect of FDI on economic growth but no evidence of spatial spillovers. Given this, the question as to whether there is any connection between the headquarters effect and the lack of regional spatial spillovers arises. To answer this question, we compute the headquarters effect and obtain a new set of FDI data. As expected, the re-estimation of the model with these new data reveals the presence of strong FDI spatial spillovers. Thus, our findings provide evidence of the fact that economic growth in a region is positively affected not only by the inward FDI in that region (direct effect) but also by the FDI received by neighboring regions (indirect effect). Furthermore, the computation of the matrix of effect estimates associated with FDI offers new insights: on the one hand, and as it seems logical, that the direct effect turns out to be the greatest one when all the effects are considered individually; on the other, that the closer the regions are to the one under consideration, the higher the spillover effects.

The main result of the paper, the emergence of FDI spatial spillovers on growth once the headquarters effect has been properly addressed, is robust to the inclusion of Cataluña in its computation and to the use of different specifications of the spatial weight matrix. Besides, the results from the sectoral breakdown of FDI data tend to reinforce the aggregate ones but also unveil the important result that the service sector (especially the logistics branch) is, regarding foreign capital inflows, the key enhancer of regional growth.

The main conclusion to be drawn from the results is evident: we cannot rely on raw FDI data for policy issues since they are biased due to the presence and relevance of the headquarters effect. In other words, the fact that a part of total FDI is wrongly registered in the region in which the firm's headquarters is located rather than where it is really made leads to misleading results: FDI spatial spillovers, despite being instrumental to fostering economic growth, are not detected. This fact has, no doubt, an important policy implication (which would be reinforced if the result kept for different case studies): the effectiveness of regional policies is overestimated. More specifically, to attract FDI, and consequently promote economic growth, joint strategies between regions, mainly neighboring regions, along with national strategies mainly stressing three factors (investment in education, manufacturing and logistics) should be implemented.

Having said that, it is important to admit that the evidence reported in this paper is not strong enough to make more specific policy recommendations. The aforementioned above, however, would get more to the point if the headquarters effect had been estimated using FDI plant-level data or detailed FDI transaction data to capture the location of the de facto investment. Related to this, the headquarters of subsidiary firms tend to be located in major city regions but, unfortunately, statistical information is not normally given at such a disaggregate level. This is, at any rate, a potential future extension of the paper to work on, provided data are available.

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Table 1
Inward FDI in Spanish regions and sectors. Flows (million euros 2000). Average 1996-2013

	Total			Sectoral distribution (%)			
Regions	Total	CV	%	Agriculture	Industry	Construction	Services
Andalucía	397.41	0.44	2.19	2.61	31.93	21.33	44.12
Aragón	424.88	2.48	2.34	0.17	70.66	0.52	28.65
Asturias	223.02	1.70	1.23	0.00	95.25	0.61	4.13
Baleares	219.12	0.57	1.21	1.67	0.88	26.31	71.14
Canarias	496.35	0.87	2.73	1.88	51.11	2.59	44.42
Cantabria	13.08	1.18	0.07	3.29	50.54	5.89	40.29
Castilla y León	64.14	1.03	0.35	1.19	34.23	4.04	60.55
Castilla-La Mancha	82.05	1.35	0.45	1.94	40.21	12.41	45.45
Cataluña	2,765.96	0.38	15.24	0.90	43.75	3.83	51.51
C. Valenciana	683.33	1.21	3.76	0.21	70.94	2.29	26.56
Extremadura	19.09	1.00	0.11	8.59	84.87	0.37	6.18
Galicia	157.49	1.03	0.87	0.87	59.42	5.51	34.20
Madrid	11,671.85	0.69	64.30	0.52	35.69	2.77	61.02
Murcia	99.5	1.86	0.55	1.46	82.13	4.95	11.46
Navarra	55.5	0.75	0.31	1.06	68.92	6.79	23.23
País Vasco	765.73	0.92	4.22	0.22	61.52	9.42	28.85
Rioja (La)	14.45	1.19	0.08	0.48	74.55	0.35	24.62
Spain	18152.95	0.53	100	0.67	41.48	3.90	53.96

Note: CV: Coefficient of variation.
Sources: DataInvex and authors' elaboration.

Table 2
Per capita GDP growth. Spatial Durbin Model

Variables	Raw data	FDI data free from the headquarters effect
	Point estimates	Point estimates
$\sum_j w_{ij}\, \Delta Y_{jt}$	0.709*** (0.036)	0.693*** (0.035)
Y_{it-1}	-0.137*** (0.035)	-0.142*** (0.035)
$\sum_j w_{ij}\, Y_{jt-1}$	0.101* (0.058)	0.040 (0.055)
FDI_{it-1}	0.003 (0.002)	0.005 (0.004)
$\sum_j w_{ij}\, FDI_{jt-1}$	0.001 (0.006)	0.006 (0.007)
I_{it-1}	0.0003 (0.0004)	0.0004 (0.0004)
$\sum_j w_{ij}\, I_{jt-1}$	0.0002 (0.001)	0.001 (0.001)
TO_{it-1}	-0.00007 (0.0002)	-0.00008 (0.0002)
$\sum_j w_{ij}\, TO_{jt-1}$	-0.0004 (0.0007)	-0.0007 (0.0007)
HC_{it-1}	0.0008* (0.0004)	0.0008** (0.0004)
$\sum_j w_{ij}\, HC_{jt-1}$	0.001 (0.002)	0.001 (0.002)
Agr_{it-1}	-0.0001 (0.007)	-0.0001 (0.007)
$\sum_j w_{ij}\, Agr_{jt-1}$	0.008 (0.031)	0.014 (0.033)
Ind_{it-1}	0.119*** (0.015)	0.120*** (0.018)
$\sum_j w_{ij}\, Ind_{jt-1}$	0.118 (0.090)	0.150* (0.082)
Ser_{it-1}	0.004 (0.045)	-0.0009 (0.045)
$\sum_j w_{ij}\, Ser_{jt-1}$	0.373*** (0.137)	0.477*** (0.148)
d_{crisis}	-0.020*** (0.004)	-0.025*** (0.004)
Speed of convergence / Half-life	7.136 / 9.713	7.518 / 9.220
R-squared	0.814	0.830
LIK / AIC / SC	928.987 / -1823.975 / -1760.674	930.091 / -1826.182 / -1762.881

Notes: Standard errors in parentheses: *** (**) (*) Significant at 1% (5%) (10%).
Sources: DataInvex, Spanish National Statistics Institute, IVIE, DataComex, Cambridge Econometrics and authors' elaboration.

Table 3
Per capita GDP growth. Spatial Durbin Model. Average direct, indirect and total effects

	Direct effects	Indirect effects	Total effects
Raw data			
Y_{it-1}	-0.139*** (0.035)	-0.013 (0.210)	-0.152 (0.235)
FDI_{it-1}	0.004* (0.002)	0.013 (0.015)	0.017 (0.015)
I_{it-1}	0.0004 (0.0006)	0.002 (0.005)	0.002 (0.005)
TO_{it-1}	-0.0001 (0.0002)	-0.002 (0.002)	-0.002 (0.002)
HC_{it-1}	0.001*** (0.0004)	0.008 (0.008)	0.009 (0.008)
Agr_{it-1}	0.002 (0.012)	0.038 (0.122)	0.040 (0.133)
Ind_{it-1}	0.156*** (0.022)	0.734** (0.353)	0.890** (0.371)
Ser_{it-1}	0.070 (0.066)	1.311** (0.595)	1.381** (0.651)
FDI data free from the headquarters effect from Madrid			
	Direct effects	Indirect effects	Total effects
Y_{it-1}	-0.152*** (0.035)	-0.203 (0.200)	-0.355 (0.225)
FDI_{it-1}	0.007* (0.004)	0.036** (0.017)	0.043** (0.017)
I_{it-1}	0.0007 (0.0006)	0.005 (0.005)	0.006 (0.005)
TO_{it-1}	-0.0001 (0.0002)	-0.003 (0.002)	-0.003 (0.002)
HC_{it-1}	0.001*** (0.0004)	0.006 (0.007)	0.007 (0.007)
Agr_{it-1}	0.002 (0.011)	0.051 (0.116)	0.053 (0.126)
Ind_{it-1}	0.159*** (0.022)	0.784*** (0.301)	0.943*** (0.317)
Ser_{it-1}	0.072 (0.061)	1.537*** (0.557)	1.609*** (0.608)
Robustness check: FDI data free from the headquarters effect from Madrid and Cataluña			
	Direct effects	Indirect effects	Total effects
Y_{it-1}	-0.154*** (0.035)	-0.220 (0.200)	-0.374* (0.225)
FDI_{it-1}	0.008* (0.004)	0.039** (0.017)	0.047** (0.018)
I_{it-1}	0.0007 (0.0006)	0.005 (0.005)	0.006 (0.005)
TO_{it-1}	-0.0001 (0.0002)	-0.003 (0.002)	-0.003 (0.002)
HC_{it-1}	0.001*** (0.0004)	0.006 (0.007)	0.007 (0.007)
Agr_{it-1}	0.002 (0.011)	0.054 (0.116)	-0.056 (0.126)
Ind_{it-1}	0.160*** (0.023)	0.807*** (0.296)	0.967*** (0.312)
Ser_{it-1}	0.076 (0.061)	1.582*** (0.559)	1.658*** (0.611)

Notes: Standard errors in parentheses: *** (**) (*) Significant at 1% (5%) (10%).
Sources: DataInvex, Spanish National Statistics Institute, IVIE, DataComex, Cambridge Econometrics and authors' elaboration.

Table 4
FDI determinants. Spatial Autoregressive Model

Variables	Equation (2)	Equation (5)
	Point estimates	Point estimates
$\sum_j w_{ij}\, fdi_{jt}$	0.167*** (0.059)	0.243*** (0.089)
GDP_{it}	0.416*** (0.078)	0.266*** (0.086)
EW_{it}	5.750*** (1.656)	4.996*** (1.632)
RI_{it}	0.188 (0.134)	0.140 (0.132)
d_{Madrid}	1.496*** (0.319)	1.884*** (0.329)
$d_{Cataluña}$		1.122*** (0.298)
R-squared	0.677	0.715
LIK / AIC / SC	-486.580 / 985.161 / 1007.827	-479.66 / 973.33 / 999.77

Notes: Standard errors in parentheses: *** (**) (*) Significant at 1% (5%) (10%).
Sources: DataInvex, Spanish National Statistics Institute, Cambridge Econometrics, Eurostat and authors' elaboration.

Table 5
S(W) matrix of effect estimates for the FDI 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)
Andalucía	0.00679	0.00214	0.00184	0.00129	0.00052	0.00219	0.00242	0.00289	0.00153	0.00215	0.00250	0.00151	0.00283	0.00229	0.00236	0.00247	0.00267
Aragón	0.00151	0.00727	0.00167	0.00145	0.00040	0.00224	0.00218	0.00240	0.00211	0.00245	0.00153	0.00127	0.00246	0.00192	0.00333	0.00293	0.00326
Asturias	0.00159	0.00204	0.00702	0.00114	0.00045	0.00303	0.00306	0.00225	0.00144	0.00179	0.00187	0.00233	0.00256	0.00165	0.00249	0.00281	0.00288
Baleares	0.00165	0.00264	0.00169	0.00654	0.00048	0.00213	0.00214	0.00238	0.00262	0.00261	0.00162	0.00133	0.00239	0.00218	0.00263	0.00258	0.00277
Canarias	0.00199	0.00219	0.00200	0.00144	0.00587	0.00229	0.00239	0.00242	0.00167	0.00208	0.00204	0.00174	0.00252	0.00201	0.00245	0.00257	0.00271
Cantabria	0.00148	0.00215	0.00238	0.00113	0.00040	0.00735	0.00296	0.00223	0.00146	0.00179	0.00165	0.00156	0.00257	0.00162	0.00280	0.00348	0.00337
Castilla y León	0.00163	0.00208	0.00239	0.00112	0.00042	0.00294	0.00735	0.00245	0.00142	0.00183	0.00191	0.00167	0.00304	0.00169	0.00254	0.00285	0.00303
Castilla-La Mancha	0.00194	0.00228	0.00174	0.00124	0.00042	0.00221	0.00243	0.00738	0.00153	0.00229	0.00187	0.00136	0.00353	0.00225	0.00249	0.00257	0.00286
Cataluña	0.00155	0.00303	0.00168	0.00207	0.00044	0.00218	0.00214	0.00232	0.00679	0.00246	0.00156	0.00130	0.00237	0.00198	0.00287	0.00273	0.00292
C. Valenciana	0.00171	0.00276	0.00164	0.00162	0.00043	0.00211	0.00216	0.00271	0.00193	0.00712	0.00163	0.00128	0.00255	0.00274	0.00261	0.00256	0.00281
Extremadura	0.00238	0.00207	0.00206	0.00120	0.00051	0.00233	0.00271	0.00266	0.00147	0.00196	0.00684	0.00176	0.00290	0.00193	0.00237	0.00253	0.00271
Galicia	0.00171	0.00204	0.00306	0.00117	0.00051	0.00262	0.00280	0.00230	0.00146	0.00183	0.00209	0.00667	0.00256	0.00171	0.00242	0.00266	0.00276
Madrid	0.00178	0.00219	0.00187	0.00117	0.00041	0.00239	0.00283	0.00331	0.00147	0.00202	0.00191	0.00142	0.00748	0.00189	0.00253	0.00270	0.00301
Murcia	0.00201	0.00238	0.00168	0.00150	0.00046	0.00210	0.00221	0.00295	0.00172	0.00303	0.00177	0.00133	0.00265	0.00698	0.00245	0.00248	0.00271
Navarra	0.00140	0.00280	0.00171	0.00122	0.00038	0.00246	0.00223	0.00220	0.00168	0.00195	0.00147	0.00127	0.00239	0.00166	0.00766	0.00381	0.00408
País Vasco	0.00139	0.00234	0.00183	0.00113	0.00037	0.00289	0.00238	0.00216	0.00151	0.00181	0.00149	0.00132	0.00241	0.00158	0.00360	0.00782	0.00436
Rioja (La)	0.00141	0.00244	0.00176	0.00114	0.00037	0.00263	0.00238	0.00225	0.00152	0.00187	0.00150	0.00129	0.00253	0.00163	0.00363	0.00410	0.00794

Sources: DataInvex, Spanish National Statistics Institute, IVIE, DataComex, Cambridge Econometrics and authors' elaboration.

Table 6
Robustness check for the spatial growth model. Alternative spatial weight matrices

	Five nearest neighbor spatial weight matrix			Inverse distance weight matrix standardized by its largest eigenvalue		
	Direct effects	Indirect effects	Total effects	Direct effects	Indirect effects	Total effects
Y_{it-1}	-0.138*** (0.041)	-0.036 (0.104)	-0.174 (0.114)	-0.159*** (0.041)	-0.218 (0.177)	-0.377* (0.208)
FDI_{it-1}	0.006* (0.003)	0.014* (0.007)	0.020*** (0.007)	0.009*** (0.003)	0.038** (0.015)	0.047*** (0.017)
I_{it-1}	0.0003 (0.0006)	-0.0004 (0.002)	-0.0001 (0.002)	0.0009 (0.0007)	0.006 (0.004)	0.007 (0.005)
TO_{it-1}	-0.0002 (0.0002)	-0.001 (0.001)	-0.001 (0.001)	-0.0004* (0.0002)	-0.002 (0.001)	-0.002* (0.001)
HC_{it-1}	0.0002 (0.0006)	0.002 (0.005)	0.002 (0.005)	0.002*** (0.0004)	0.004 (0.004)	0.006 (0.005)
Agr_{it-1}	-0.007 (0.010)	-0.025 (0.064)	-0.032 (0.073)	0.013 (0.010)	0.063 (0.091)	0.076 (0.100)
Ind_{it-1}	0.121*** (0.019)	0.270** (0.108)	0.391*** (0.119)	0.155*** (0.020)	0.775*** (0.236)	0.930*** (0.253)
Ser_{it-1}	0.009 (0.057)	0.396* (0.230)	0.405 (0.272)	0.169*** (0.065)	1.517*** (0.436)	1.686*** (0.489)

Notes: Standard errors in parentheses: *** (**) (*) Significant at 1% (5%) (10%).
Sources: DataInvex, Spanish National Statistics Institute, IVIE, DataComex, Cambridge Econometrics and authors' elaboration.

Table 7
Robustness check for the spatial growth model. Sectoral breakdown

	Industry			Services			Industry and services		
	Direct effects	Indirect effects	Total effects	Direct effects	Indirect effects	Total effects	Direct effects	Indirect effects	Total effects
Y_{it-1}	-0.1229***	0.1534	0.0305	-0.1238***	0.1413	0.0175	-0.1048***	-0.2247**	-0.3295***
	(0.0431)	(0.0562)	(0.0105)	(0.0359)	(0.1082)	(0.1279)	(0.0322)	(0.0951)	(0.1244)
$FDI_{it-1}^{k=1}$	0.0022*	0.0231*	0.0253**				0.0022*	0.0150	0.0172
	(0.0011)	(0.0122)	(0.0119)				(0.0012)	(0.0146)	(0.0148)
$FDI_{it-1}^{k=2}$	0.0003	-0.0011	-0.0008				-0.0001	-0.0002	-0.0003
	(0.0008)	(0.0080)	(0.0083)				(0.0005)	(0.0012)	(0.0017)
$FDI_{it-1}^{k=3}$				-0.0007	0.0137	0.0130	-0.0018	-0.0037	-0.0055
				(0.0016)	(0.0127)	(0.0142)	(0.0012)	(0.0023)	(0.0041)
$FDI_{it-1}^{k=4}$				0.0009**	0.0020**	0.0029*	0.0009**	0.0020*	0.0029**
				(0.0004)	(0.0009)	(0.0014)	(0.0004)	(0.0010)	(0.0015)
$FDI_{it-1}^{k=5}$				0.0006	0.0011	0.0017	0.0021*	0.0042*	0.0063*
				(0.0015)	(0.0033)	(0.0049)	(0.0012)	(0.0022)	(0.0034)
I_{it-1}	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0001)	(0.0001)
TO_{it-1}	-0.0005**	-0.0010**	-0.0015**	-0.0000	-0.0021	-0.0021	-0.0001	-0.0025	-0.0026
	(0.0002)	(0.0004)	(0.0006)	(0.0002)	(0.0015)	(0.0015)	(0.0002)	(0.0022)	(0.0024)
HC_{it-1}	-0.0001	-0.00001	-0.0001	0.0004	-0.0005	-0.0001	0.0009**	0.0056	0.0065
	(0.0011)	(0.0022)	(0.0033)	(0.0004)	(0.0060)	(0.0062)	(0.0004)	(0.0057)	(0.0058)
Agr_{it-1}	-0.0055	-0.0117	-0.0172	0.0035	-0.0463	-0.0428	-0.0032	-0.0617	-0.0649
	(0.0096)	(0.0199)	(0.0295)	(0.0112)	(0.1149)	(0.1244)	(0.0096)	(0.0812)	(0.0891)
Ind_{it-1}	0.0758***	0.1542***	0.2300***	0.1469***	0.8303*	0.9772*	0.0962***	0.2047***	0.3009***
	(0.0154)	(0.0309)	(0.0449)	(0.0420)	(0.4773)	(0.5142)	(0.0212)	(0.0679)	(0.0860)
Ser_{it-1}	0.0653**	0.1332*	0.1985*	0.1305	1.4877	1.6182	0.0273	0.0764	0.1037
	(0.0356)	(0.0726)	(0.1077)	(0.0942)	(0.9318)	(1.0132)	(0.0497)	(0.2413)	(0.2644)

Notes: *k*: branches of industrial (*k* =1,2) and service sectors (*k*=3,4,5). Standard errors in parentheses: *** (**) (*) Significant at 1% (5%) (10%).
Sources: DataInvex, Spanish National Statistics Institute, IVIE, DataComex, Cambridge Econometrics and authors' elaboration.

Appendix.

Here we report the results obtained when FDI variable, rather than one period, is lagged from 2 to 4 periods to make sure that potential endogeneity problems vanish. For the sake of simplicity, we show average direct, indirect and total effects for our benchmark model (namely, aggregate data and the row-standardized spatial distance weight matrix). As can be seen, the main results are roughly the same. Once the headquarters effect is properly addressed, spatial spillover effects arise as an important factor explaining economic growth. There is, however, an additional conclusion: the effect of FDI on economic growth tends to fade away when the time lag gets longer.

Table A.1

Per capita GDP growth. Spatial Durbin Model with alternative FDI lags. Average direct, indirect and total effects

	Direct effects	Indirect effects	Total effects
Y_{it-1}	-0.170*** (0.024)	-0.193 (0.268)	-0.363 (0.282)
FDI_{it-2}	0.005* (0.002)	0.039** (0.017)	0.044** (0.017)
I_{it-1}	0.0007* (0.0004)	0.005 (0.004)	0.006 (0.004)
TO_{it-1}	-0.0001 (0.0002)	-0.002* (0.001)	-0.002* (0.001)
HC_{it-1}	0.001 (0.0007)	0.004 (0.006)	0.005 (0.007)
Agr_{it-1}	0.001 (0.008)	0.080 (0.112)	0.081 (0.117)
Ind_{it-1}	0.176*** (0.026)	0.693** (0.304)	0.869*** (0.319)
Ser_{it-1}	0.072 (0.063)	1.491** (0.593)	1.563** (0.629)
Y_{it-1}	-0.195*** (0.032)	-0.202 (0.200)	-0.397* (0.217)
FDI_{it-3}	0.010*** (0.003)	0.026* (0.014)	0.036** (0.016)
I_{it-1}	0.0004 (0.0006)	0.005 (0.004)	0.006 (0.005)
TO_{it-1}	-0.0001 (0.0003)	-0.003* (0.001)	-0.003* (0.001)
HC_{it-1}	0.001*** (0.0004)	0.004 (0.003)	0.005 (0.003)
Agr_{it-1}	0.004 (0.015)	0.106 (0.133)	0.110 (0.147)
Ind_{it-1}	0.177*** (0.036)	0.481*** (0.311)	0.658* (0.341)
Ser_{it-1}	0.021 (0.090)	1.117 (0.735)	1.138 (0.813)
Y_{it-1}	-0.218*** (0.025)	-0.235 (0.248)	-0.453* (0.256)
FDI_{it-4}	0.010*** (0.003)	0.029** (0.013)	0.039*** (0.014)
I_{it-1}	0.0006 (0.0003)	0.006* (0.003)	0.007* (0.003)
TO_{it-1}	-0.0001 (0.0002)	-0.004** (0.001)	-0.004** (0.001)
HC_{it-1}	0.001 (0.0007)	0.004 (0.005)	0.005 (0.005)
Agr_{it-1}	0.008 (0.012)	0.158 (0.101)	0.166 (0.107)
Ind_{it-1}	0.188*** (0.030)	0.486* (0.266)	0.674** (0.281)
Ser_{it-1}	0.039 (0.069)	1.217** (0.552)	1.256** (0.596)

Notes: Standard errors in parentheses: *** (**) (*) Significant at 1% (5%) (10%).

Sources: DataInvex, Spanish National Statistics Institute, IVIE, DataComex, Cambridge Econometrics and authors' elaboration.