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The Spatial Dimension in FDI Spillovers: Evidence at the Regional Level from Portugal

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WORKING PAPERS

The Spatial Dimension in FDI Spillovers: Evidence at the Regional Level from Portugal[1]

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Abstract: There are theoretical reasons to expect that benefits to domestic firms from foreign direct investment would be confined to the area where the multinational firm is located and that the benefits depend on the development level of the host region. However, there is a scarcity of empirical studies on FDI's indirect effects at the regional level, particularly with regard to inter-industry spillovers. This paper is an empirical contribution to this literature with data for Portugal. Both intra-industry and inter-industry FDI spillovers are considered. The concept of region adopted comprises the county in which the domestic firm is located, together with all of the directly neighbouring counties. Equations are estimated using the System GMM, with robust estimation of covariance matrices. Data confirms the relevance of both the geographical proximity and the development level of the region to this phenomenon. Furthermore, FDI spillovers are more evident at the inter-industry level. These results raise important implications for economic policy.

Key Words: Portugal, FDI intra-industry spillovers, FDI inter-industry spillovers, counties, regional development level, geographical proximity.

JEL: F21, F23

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1. Introduction

FDI is widely accepted to be an important element of the development strategy pursued by most countries, due not only to the direct effects that are generated (such as job creation, capital formation, growth of fiscal income, the contribution to the transformation of the productive and exporting structures of the host economies), but also to the possibility of domestic firms to have access to more advanced and efficient technologies, thereby achieving greater productivity.

The expectation of obtaining these benefits has led to the attribution of significant incentives designed to attract FDI. Reflecting the prominent position that this issue has assumed in terms of economic policy, much interest has arisen in research into the effective existence of this technology transfer in favour of domestic firms. Starting with the pioneering contribution of Caves (1974), three fundamental strands can be identified in the research into FDI spillovers. The first, which was dominant until the 1990s, basically consisted of the evaluation of the existence of intra-industry spillovers, based on sectional data, the evidence being abundantly favourable to the existence of spillovers. However, the studies of Haddad and Harrison (1993) and Aitken and Harrison (1999), using panel data, raised serious doubts as to the previous conclusion. These works gave rise to a vast body of studies using panel data and frequently extending the analysis to inter-industry effects (Barrios and Strobl, 2002; Damijan et al. 2003; Yudaeva et al., 2003; Kugler, 2006; Mullen and Williams, 2007).

Most of the conclusions of this strand are much less optimistic than those of the first strand, with many non-significant or even negative results (Görg and Greenaway, 2004).

These findings led to a third line of analysis on FDI spillovers, based on the assumption that spillover effects are probably not a universal occurrence. The analysis focuses on the determination of the factors that condition the existence, sign and dimension of such effects. These factors include the capacity of domestic firms to absorb the foreign technology, the size and the market share of domestic firms, the export capacity of domestic firms, the geographical proximity between MNCs and domestic firms, the development level of the host country/region, the degree of foreign ownership of the MNCs' affiliates, the FDI entry mode, the home country from which the FDI emanates, the nature of the trade policy regime, the existence of intellectual property rights, the kind of labour training implemented by the MNC, the

competition level, the "value" of the foreign technology and the FDI motivation (Crespo and Fontoura, 2007). With the exception of the importance of a moderate technological gap between MNCs and domestic firms, the evidence existing in relation to these factors is, however, still largely inconclusive, insofar as the studies carried out arrive at contrary conclusions, or are insufficient to obtain a reliable conclusion as to the effective relevance of the factors identified.

With the aim of minimising this limitation, the present paper follows this most recent strand of the literature on FDI spillovers, specifically analysing the possible interaction between two of the determinant factors mentioned above. The factors that are analysed – geographical proximity between MNCs and domestic firms and the development level of the host region – have in common the fact that they both consider space to be a characteristic that affects the capture of FDI spillovers by domestic firms.

To summarise, this paper seeks to answer two fundamental questions in the context of FDI spillover evaluation:

(i) Is geographical proximity between MNCs and domestic firms of importance for the occurrence of the effects?

(ii) Does the level of development in the host region influence the occurrence of spillovers?

Making use of statistical data on the Portuguese economy, we evaluate the influence of these two factors. In previous studies the effect of immediate locality of the inward investment to the creation and transmission of FDI externalities has received limited attention while evidence on the effect of regional hetereogoneity is even scarcer. To our best knowledge this study represents the first attempt to analyse the combined influence of these two factors. Besides, we take into consideration intra- and inter-industry effects, as suggested by Jordaan (2008b). Relatively to previous studies, the concept of region used is much more disaggregated and specially built for the purpose of this analysis.

The paper is organized as follows. Section 2 presents a brief description of the main channels through which the spillover effect can occur in favour of domestic firms. Section 3 discusses the importance of the spatial dimension in the verification of this effect. Section 4 presents the empirical model used and discusses the results obtained. Section 5 presents some final remarks.

2. FDI Spillovers – channels of technological transmission

There are several channels by which the occurrence of FDI spillovers can be verified: demonstration/imitation, labour mobility, exports, competition and backward and forward linkages with domestic firms (Görg and Greenaway, 2004; Halpern and Muraközy, 2005; Crespo and Fontoura, 2007).

The most obvious channel for the emergence of FDI spillovers is the existence of demonstration (by the MNCs)/imitation (by domestic firms) effects (Das, 1987; Wang and Blomström, 1992). In fact, the introduction of a new technology in a given market may be too expensive and risky for the domestic firms. In this context, the introduction of the new technology by a MNC may operate as a guarantee of the viability of this technology in the market in question. This fact represents an important incentive for the domestic firms to adopt that technology through an imitation process.

A second channel is related to labour mobility. As shown for instance by Fosfuri et al. (2001), Glass and Saggi (2002) or Görg and Strobl (2005), the domestic firms may hire workers who, having previously worked for a MNC, already have experience of the tecnology. However, it is not possible to exclude a potential negative effect through this channel, namely, that MNCs may attract the best workers away from domestic firms by offering higher wages (Sinami and Meyer, 2004).[2]

Another possible channel for FDI spillovers is related to exports (Aitken et al., 1997; Kokko et al., 2001). In fact, the export activity implies costs associated with the establishment of distribution networks, transport infrastructures or knowledge of consumers' tastes in foreign markets. Through an imitation process (or, in some cases, through collaboration), the domestic firms can copy the export process of foreign firms, reducing the entry costs into the foreign market and, potentially, improving their efficency level (Girma, 2003; Greenaway et al., 2004; Madariaga and Poncet, 2007).

A fourth channel for FDI spillovers to domestic firms is the competition induced by MNCs in the domestic market (Markusen and Venables, 1999; Glass and Saggi,

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[2] It is important to note, however, that the occurrence of FDI spillovers through this channel is not easy to measure, since the analysis of the impact of labour mobility on the efficiency of domestic firms involves tracking the workers in order to measure their influence on the productivity of other workers (Saggi, 2002).

2002). On one hand, this increased competition represents an important incentive for the domestic firms to achieve a more efficient utilisation of existing technology, or even to adopt a new technology. In contrast to this positive effect, the foreign presence may induce significant reductions of market share for domestic firms, driving operations to a less efficient scale, with the associated increase in average costs (Aitken and Harrison, 1999).

As emphasised, for instance, by Rodríguez-Clare (1996), Markusen and Venables (1999) and Blalock and Gertler (2008), a final channel for FDI spillovers concerns the relationships that domestic firms establish in local markets as suppliers to MNCs (backward linkages), or as customers of intermediate inputs produced by them (forward linkages).

Given the increasing returns to scale, the presence of MNCs in the domestic market may benefit domestic suppliers if the demand for local inputs increases as a result. In addition, the MNCs may require the domestic suppliers to restructure in order to achieve the appropriate quality (Blalock and Gertler, 2008). The MNCs may encourage domestic suppliers to achieve a certain quality pattern through several means: providing technical support for the improvement of the quality of goods, or for the introduction of innovations (through labour training, for instance); providing support for the construction of productive infrastructures and for the acquisition of raw materials, as well as support at the organisational and management levels, among other aspects (Lall, 1980; Driffield et al., 2004; Reganati and Sica, 2005). Higher prices paid for the inputs may also improve the productivity of domestic sellers. Nevertheless, as pointed out by Halpern and Muraközy (2005), the fact cannot be excluded that, due to their better bargaining position, foreign firms are capable of lowering input prices, leading to a negative impact on productivity. Another negative effect may occur if foreign firms are not satisfied with the quality of local suppliers, thus leading to the termination of existing relationships (Yudaeva et al., 2003).

With regard to forward linkages, the most evident link consists of the MNCs' supply of higher quality inputs, and/or at a lower price, to domestic producers of end-user consumer goods (Markusen and Venables, 1999). Moreover, as suggested by Dunning (1993), MNCs may also benefit their domestic customers by introducing them to new management techniques and production processes. However, a potential negative impact may also occur, since the higher quality associated with the presence of the MNC may cause an increase in prices (Javorcik, 2004).

3. Assessment of FDI Spillovers at the regional level

In this section, we present the theoretical arguments that support the relevance of the two determinant factors of FDI spillovers with a spatial dimension considered in this paper - the geographical proximity between MNCs and domestic firms and the development level of the host regions - and summarise the related evidence already produced[3].

Let us first consider the importance of geographical proximity in the diffusion of technology. The main argument that has been proposed is that, in theoretical terms, all of the five channels of FDI spillovers presented in Section 2 are reinforced when a smaller geographical area is considered (Aitken and Harrison, 1999; Girma, 2003; Madariaga and Poncet, 2007; Barrios et al., 2007; Resmini and Nicolini, 2007; Jordaan, 2008 a,b).

Several reasons have been put forward to justify the argument that benefits to domestic firms from foreign investment would be confined to the area where the MNC is located (Girma, 2003). First, the demonstration effects from MNCs to domestic firms (in relation to both production and exports) are more likely to occur at local level, since the benefits are likely to extend (at least initially) to neighbouring firms. Second, a worker who leaves an MNC seeking employment at a domestic firm is likely to prefer to remain in the same region. Third, in order to reduce transaction costs and facilitate communication with the domestic supplier, MNCs will probably prefer local linkage industries. Fourth, the competition between MNCs and domestic firms will be more accentuated (with the positive and negative impacts described above) on the local scale.

The importance of the domestic firms' capacity of absorption has been one of the most analysed determinant factors of FDI spillovers in theoretical, and above all, empirical terms. However, a small number of studies have widened the analysis of the capacity of absorption to the macro level, taking into account countries or regions. These studies suggest that the existence of a sufficient capacity of absorption on the part of host regions of FDI is fundamental to the emergence of spillovers. The

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[3] Recently, the influence of space has also been evaluated in terms of interregional spillovers, i.e. whether labour productivity of a given region is affected by labour productivity of surrounding regions owing to spatial interactions (see, for instance, Ozyurt, 2008).

capacity is usually measured by means of an indicator of development, such as income per capita.

In spite of the theoretical arguments supporting the importance of space in the emergence of spillovers, the empirical evidence with regard to the determinant factors analysed in this paper is, thus far, scarce and not strongly conclusive.

Most of the studies which consider the geographical proximity allow for horizontal spillovers only. This is the case of Sjöholm (1999), Aitken and Harrison (1999) and Yudaeva et al. (2003), with data for Indonesia, Venezuela and Russia, respectively, none of which confirm the relevance of a geographically limited area to the occurrence of the phenomenon. However, other similar studies draw conclusions to the contrary: Ponomareva (2000) with data for Russia; Girma and Wakelin (2001), Driffield and Munday (2001), Girma (2003) and Haskel et al. (2007) with data for the United Kingdom; Wei e Liu (2004) with data for China; Torlak (2004) considering the case of the Czech Republic and Poland; and Halpern and Muraközy (2005) for Hungary. Nevertheless, in Torlak's study, when the so-called agglomeration effect is controlled, the positive influence only holds firm in the case of the Czech Republic.

With regard to vertical spillovers, there are hardly any empirical studies at the regional level. Notable exceptions are the papers by Halpern and Muraközy (2005) and Driffield et al. (2004), for Hungary and the UK respectively. The former finds (statistically significant) inter-sectoral and backward FDI spillovers for domestically-owned firms in the national space, but not at the regional level. The latter provides some evidence on the expected effect when domestic firms purchase from foreign firms.

More recently, Resmini and Nicolini (2007) confirm, with data for Bulgaria, Poland and Romania, the importance of geographical proximity to the existence of spillovers at both the intra- and inter-industry levels, although it is stronger in the former case. On the other hand, Blalock and Gertler (2008), observing the regional level for the Indonesian case, find evidence that supports the existence of an inter-sector effect, but do not confirm the existence of an intra-sector effect. Similarly, Jordaan (2008a, b), studying the case of Mexico, and Crespo and Fontoura (2009) with data for Portugal, detect a negative intra-industry effect and a positive inter-sector effect.

Evidence on host regions' capacity of absorption influence is scarce. Jordaan (2008a, b) observes that the characteristics of the regions influence the occurrence of

spillovers. Overall, he concludes that regional specialisation and diversity influence the spillover manifestation process. Sgaard (2001) finds evidence, in the Hungarian case, that FDI mostly benefit firms located in the most developed region, closer to EU border.

4) FDI Spillovers in the Portuguese Case

4.1) The model

The existence of FDI spillovers is usually tested in the context of a regression in which several determinant factors of domestic firms' efficiency are considered, including the magnitude of the foreign presence. Despite the fact that labour productivity is, at best, a partial measure of overall multi-factor productivity, if spillovers occur, there should be higher labour productivity levels for domestic firms in sectors with a larger foreign presence (Mullen and Williams, 2007). Therefore, as assumed in many of the empirical studies in this area, we consider the labour productivity of the domestic firm i, in the year t ($PROD_{it}$) – total value added divided by the number of workers – as the dependent variable, aiming to proxy the efficiency level of domestic firms.

To test for the existence of FDI spillovers to domestic firms, we construct several variables that capture the magnitude of the foreign presence. With this objective, we use data on employment, as, for instance, Keller and Yeaple (2003), Girma (2003), Karpaty and Lundberg (2004), Resmini and Nicolini (2007) and Jordaan (2008b).

We measure the dimension of the external presence through three variables defined at national level (*FPN1*, *FPN2* and *FPN3*) and three others constructed at regional level (*FPR1*, *FPR2* and *FPR3*).[4]

The variable *FPN1* aims to capture the existence of intra-industry spillovers at the national level. It is constructed as the weight of employment in the foreign firms in the total employment of the sector where the firm i operates. The possible existence of inter-industry spillovers is analysed through the variables *FPN2* and *FPN3*. *FPN2* evaluates the occurrence of inter-industry spillovers in the case in which foreign firms

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[4] See the appendix for a more detailed description of these variables.

supply local firms (forward linkages). This variable is constructed as a weighted average of the relative dimension of foreign presence in each sector (captured by the *FPN1* values). The weight of each sector is given by the importance, for the sector where firm i operates, of the various supplying sectors (excluding the sector in which firm i operates). The same procedure is used to obtain the variable *FPN3*, but now with the focus on backward linkages, i.e., the relation in which the foreign firms are supplied by the local firms.

The variables *FPR1*, *FPR2* and *FPR3* aim to capture the existence of a regional dimension in FDI spillovers in the Portuguese case. They are obtained through the same procedure described for the variables *FPN1*, *FPN2* and *FPN3* respectively, but now in the context of regional geographical units.

The concept of region used is defined as the county in which the domestic firm is located[5], together with all of the directly neighbouring counties. Most studies that investigate the possible existence of a regional effect in the occurrence of FDI spillovers have adopted, in spatial terms, the countries' administrative divisions as the criterion for the definition of the regions. This procedure, despite the fact that it simplifies the analysis, leads to greater difficulties in respect of the evaluation of the geographical proximity effect, as the regional boundary is not necessarily related to the distance effect that we aim to capture. Indeed, two firms may be in different administrative divisions, but still geographically close to each other. [6]

Besides the variables which intend to capture the dimension of the foreign presence, we consider a group of control variables that may have influence on the efficiency level of the domestic firms. These variables are presented in Table 1.

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[5] Mainland Portugal (i.e., excluding the islands of Madeira and Azores) is divided into 275 counties.

[6] It is important to note that, due to data limitations, in the construction of FPR2 and FPR3, we had to assume that the weights remain constant across regions, i.e., we consider the same weights for inter-sectoral relations used for the variables at the national level.

Table 1 - The Control Variables of the Model

$H_{it} = \sum_{g \in J} \left(\dfrac{X_{gt}}{\sum_{g \in J} X_{gt}} \right)^2 \times 100$	**degree of concentration** – Herfindhal concentration index, where X_{gt} represents the output of firm g, at time t; g is an index for the firms (domestic or foreign) belonging to sector J to which domestic firm i belongs.
SE_{it}	**scale economies** – ratio between the production of firm i, at time t and the average value of the production of the y largest firms in the sector where the firm i operates, at the same time t. The value of y is obtained as the largest entire value found in $1/H_{it}$.
SL_{it}	**skilled labour** – total remuneration per worker in domestic firm i, at time t.
CI_{it}	**capitalistic intensity** – total fixed assets of domestic firm i divided by the number of workers of firm i, at time t.

Finally, in order to control for the productivity evolution of the Portuguese domestic firms, we include in the regression annual dummy variables (*D1997*, *D1998* and *D1999*).

To sum up, the model [1] is expressed as:

$$PROD_{it} = \beta_1 + \sum_{j=1}^{3} \theta_j FPNj_{it-1} + \sum_{j=1}^{3} \psi_j FPRj_{it-1} + \beta_2 SL_{it} + \beta_3 SE_{it} + \beta_4 CI_{it}$$
$$+ \beta_5 H_{it} + \sum_{l} \lambda_l Dl_{it} + \eta_i + \varepsilon_{it} \qquad i = 1,...,n; t = 1996,...,2000$$

where D_l (*l=1997,...,2000*) are the time dummies, η_i is the specific non-observed effect of the firm on productivity (constant through the time), while ε_{it} represents the random error.

In order to test the relevance of the development level of the host region, we disaggregate the full sample into two groups, according to the level of development, which is measured using data from the Human Development Index (HDI) at regional level. As is well known, the HDI is a composite index which considers three main dimensions: income, health and education. For the purpose of this study, we consider the information supplied by Cónim (1999), who calculated this index for all of the Portuguese counties.

The HDI values pertaining to the Portuguese counties clearly show that the most developed counties are all situated along the country's western coastal strip[7] – coinciding with the areas of greatest concentration of economic activity – in which the regions of Greater Porto and Greater Lisbon are the most prominent. Table 2 presents the counties with the highest and lowest HDI values.

Table 2 – The Portuguese Counties with the Highest and Lowest HDI Values

The 10 counties with the highest HDI		The 10 counties with the lowest HDI	
Cascais	0.939	Mértola	0.817
Oeiras	0.938	Castro Verde	0.828
Amadora	0.937	Alcoutim	0.832
Lisboa	0.937	Resende	0.833
Sintra	0.933	Mesão Frio	0.836
Loures	0.930	Amodôvar	0.838
Mafra	0.923	Castro Marim	0.841
Porto	0.922	Aljezur	0.841
Seixal	0.921	Miranda do Douro	0.842
Matosinhos	0.920	Serpa	0.845

Source: Cónim(1999)

Equation (1) was estimated using the System GMM, proposed by Blundell and Bond (2000), with robust estimation of covariance matrices. The estimation of the covariance matrix was considered robust to heteroskedasticity (among firms) and to (unknown) autocorrelation[8]. This method has been popularised for dynamic autoregressive models. However, it can be successfully applied to more general models in order to avoid estimation bias due to unobserved heterogeneity and/or simultaneity, which is the case in the present study. In fact, we suspect that unobserved heterogeneous causes, which are constant in time and that influence productivity, depend on the explanatory variables of the model and that the variables related to the dimension of the foreign presence in the same sector, as well as the variable *SL,* are endogenous. It is well known that high-productivity sectors or firms may attract the location of MNCs in the same sector (Aitken and Harrison, 1999), yielding a positive relationship even without the occurrence of spillovers. Furthermore,

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[7] Analysis of the spatial distribution of manufacturing industry in Portugal (both domestic and multinational companies) enables us to verify a strong concentration on the western coast of the country, between Braga and Setúbal, particularly in the north and Greater Lisbon. Crespo et al. (2009) show that this area contains the 16 counties with the strongest presence (in relative terms) of MNCs, as well as the 25 counties with the strongest presence of domestic firms.

[8] The calculations were obtained with the *Stata*, using the *xtabond2* module developed by Roodman (2005) with Windmeijer correction.

it is plausible that workers' remuneration (the proxy used for skilled labour) may also depend on productivity itself. Moreover, the additional linear conditions proposed by the system GMM, in contrast to the classic GMM of Arellano and Bond (1991), may improve estimation results, particularly when weak instruments are present, due to the weak correlation of first-differences with lagged values of endogenous or pre-determined variables.

It is fair to assume that the domestic firms are likely to require some time to adjust to the foreign presence. In order to take this fact into consideration, we consider, as other studies on this question, a dynamic model (Driffield, 2006). Therefore, we run all the regressions with a one-year lag for the foreign presence.

The empirical measurement considers data for the Portuguese economy at the level of manufacturing industry in the period 1996-2000. The analisis is based on two statistical sources: Dun & Bradstreet and *Quadros de Pessoal* – Portuguese Ministry of Employment.

The Dun & Bradstreet data contains information, at micro level, on 1,303 Portuguese enterprises for each of the five years considered, which enabled us to obtain a panel data comprising 6,515 observations. With regard to the foreign establishments operating in Portugal, the source provided us with information on 266 firms in 1996, 262 in 1997, 300 in 1998, 322 in 1999 and 275 in 2000. This sample provided information on the location (county) of the establishments and allowed us to obtain the variables PROD, SL, SE, CI and H.

Quadros de Pessoal is an annual longitudinal dataset compiled from a survey conducted by the Portuguese Ministry of Employment. Completion of the survey form is mandatory for all establishments employing wage-earners. In the period covered in this study, the dataset includes an average number of 26,428 manufacturing firms and 822,733 workers. This statistical source was used to build the six variables FP, which measure the magnitude of the foreign presence (both at national and regional level).

4.2) Empirical evidence

With the aim of testing for the existence of a spatial dimension in the occurrence of FDI spillovers, the sample is divided into two groups, based on the counties' level of development, measured by means of the HDI. The first group comprises those regions with low and average development (values below the average HDI + 1 standard deviation), while the second group consists of the regions registering the highest development and therefore, a greater capacity of absorption (values equal to, or above, the average HDI + 1 standard deviation).

The results obtained from the estimation of (1) for the two groups of regions are presented in Table 3 (column 1 corresponds to the first group and column 2 to the second one).

Table 3 – Spatial Dimension in FDI Spillovers: Estimation results (I)

Independent variables	[1]	[2]
C		
FPN1	-0.12	51.43
	(-0.00)	(0.79)
FPN2	-5.16	-27.30
	(-0.17)	(-0.84)
FPN3	57.48	-61.99
	(1.22)	(-1.35)
FPR1	-64.12	-80.79
	(-0.68)	(-1.22)
FPR2	68.44	14.17
	(1.48)	(0.38)
FPR3	-16.91	99.42*
	(-0.34)	(1.79)
H	-9030.20	8307.16
	(-0.45)	(0.62)
SE	2.88	26.77
	(0.33)	(1.62)
SL	1.65***	1.43***
	(6.16)	(13.95)
CI	0.09**	0.15***
	(2.23)	(6.20)
Hansen Test	23.54	29.31
(p-value)	(0.430)	(0.170)
Arellano-Bond Test		
for AR(1)	-1.08	-0.20
(p-value)	(0.280)	(0.843)
for AR(2)	1.00	-0.98
(p-value)	(0.316)	(0.327)
Nr. of Observations	2420	2792
(nr. of firms)	(605)	(698)

t-statistics in parentheses based on robust standard-errors; *, **, *** - statistically significant at the 10%, 5% and 1% levels, respectively.

The results shown in Table 3 point to some relevant conclusions. Firstly, spillovers are only observed in the most developed regions, confirming the importance of a region's capacity of absorption. Secondly, the geographical proximity between MNCs and domestic firms is also revealed to be a factor of importance, insofar as a statistically significant effect is found only in those cases in which the presence of MNCs is measured in the context of regions that are spatially more limited. Lastly, only inter-industry effects are detected.

This latter result confirms the position of some authors, who argue that positive vertical externalities are more probable than horizontal ones, based on the fact that the possibly negative effect associated with the competition and the labour mobility channels is more likely to occur at the intra-industry level, while the efficiency gains are easier to obtain in backward-forward relations, due to greater incentive to cooperation (Kugler, 2001).[9]

The set of results displayed above reveal, on one hand, the importance of space as a conditioning variable that is fundamental to the occurrence of spillovers. On the other hand, these results suggest that the phenomenon of FDI spillovers is much more circumscript than is commonly accepted.

Model [1] ignores the possible existence of the so-called "agglomeration economies" In model [2], we include a variable (*AE*) to measure the agglomeration economies of the region in which inward investment locates (*AE*), in order to control for the possibility that the foreign presence variables are picking up the effect of economic agglomeration in a region. The hypothesis considered is that the efficiency of each firm is higher if that firm locates in a region with a high degree of economic density (Ciccone and Hall, 1996; Resmini and Nicolini, 2007; Jordaan, 2008b), due, for instance, to the concentration of suppliers, consultants, marketing arrangements, enlarged local pools of skilled labour, or specialised management (Crespo et al., 2009). Using data from *Quadros de Pessoal*, the variable *AE* is constructed, for each region i and each time-period t, as the ratio between the employment in the region and the dimension of that region.

Considering the variable *AE*, the model – model [2] – can be expressed as:

$$PROD_{it} = \beta_1 + \sum_{j=1}^{3} \theta_j FPNj_{it-1} + \sum_{j=1}^{3} \psi_j FPRj_{it-1} + \beta_2 AE_{it} + \beta_3 SL_{it} + \beta_4 SE_{it}$$
$$+ \beta_5 CI_{it} + \beta_6 H_{it} + \sum_{l} \lambda_l Dl_{it} + \eta_i + \varepsilon_{it} \qquad i = 1,..., n; t = 1996 ,..., 2000$$

Table 4 presents the results of the estimation of model [2] for the two groups of regions considered above, according to their development level, measured by the value of the HDI.

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[9] On this topic, see also Harris and Robinson (2004) and Reganati and Sica (2005).

Table 4 – Spatial Dimension in FDI Spillovers: Estimation Results (II)

Independent variables	[1]	[2]
C		
FPN1	-0.18	51.89
	(-0.00)	(0.80)
FPN2	0.89	-26.77
	(0.03)	(-0.83)
FPN3	53.38	-60.42
	(1.12)	(-1.30)
FPR1	-53.57	-78.90
	(-0.58)	(-1.19)
FPR2	65.96	12.32
	(1.45)	(0.33)
FPR3	-21.00	94.96*
	(-0.43)	(1.72)
H	-9668.76	7339.49
	(-0.48)	(0.53)
SE	4.00	26.62
	(0.45)	(1.63)
SL	1.65***	1.42***
	(6.31)	(14.75)
CI	0.09**	0.15***
	(2.20)	(6.23)
AE	-7.86	-4.71
	(-1.27)	(-0.89)
Hansen Test	24.08	29.25
(p-value)	(0.399)	(0.172)
Arellano-Bond Test		
for AR(1)	-1.08	-0.20
(p-value)	(0.280)	(0.845)
for AR(2)	1.00	-0.98
(p-value)	(0.315)	(0.327)
Nr. of Observations	2420	3490
(nr. of firms)	(605)	(698)

t-statistics in parentheses based on robust standard-errors; *, **, *** - statistically significant at the 10%, 5% and 1% levels, respectively.

The results displayed in Table 4 permit us to verify that the introduction of a variable that seeks to capture the possible agglomeration effect does not lead to any significant qualitative alterations in relation to the central question of our analysis, thus adding robustness to these results. Similarly to our earlier conclusions, only inter-industry spillovers are found (through backward linkages) and space is important for

the occurrence of such effects, both in terms of the level of development in the host region and the geographical proximity between domestic firms and MNCs.

5. Final remarks

Recent literature on FDI spillovers has concentrated on the evaluation of the factors that condition the existence, the sign and the magnitude of such effects. In this paper, we have focused on two of these determinant factors. Based on evidence for Portugal, we have evaluated the importance of the spatial dimension, expressed, firstly, in the geographical proximity between MNCs and domestic firms and secondly, in the level of development of the host regions. The results obtained suggest that the space is, effectively, important – in the two dimensions considered – for the emergence of spillovers that benefit domestic firms. Confirming some of the results found in recent literature on this topic, the principal conclusion that can be drawn from our analysis is, therefore, that the dimension of the spillover effects is far more limited than it is frequently considered to be.

Furthermore, we have confirmed the hypothesis expressed in the theoretical literature that proposes that spillover effects are most likely to occur as a result of inter-industry relationships.

The results obtained enable us to draw several important conclusions with regard to economic policy. The first – and the most general – is that the location of MNCs is of importance for the potential transfer of technology to domestic firms. Moreover, our analysis gives rise to the possibility that the direct attraction of FDI might not constitute an adequate means of promoting the development of less favoured regions, particularly with regard to the stimulation of productivity in domestic firms.[10] Other measures will have to be taken *a priori*, in order to facilitate the spillover effects, such as the promotion of the capacity of absorption of the host regions.

In relation to the field of FDI spillover research, the main topic on the agenda continues to be the identification of the factors that determine the spillover effects. Together with the spatial dimension, the existence of a moderate technological gap between MNCs and domestic firms is another factor that has been highlighted by

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[10] Nevertheless, the importance of so-called direct effects of FDI should not be disregarded.

recent empirical evidence. It will be the task of future research to expand the evidence in respect of other conditioning factors, in order to establish their effective relevance.

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Consider S the set of all sectors of the economy (at the two-digit level of the CAE – revision 2, in respect of manufacturing industry, i.e., sectors 15 to 37).[11] Define M_s and G_s respectively, the set of MNCs belonging to sector s and the set of all firms belonging to this sector. Foreign presence is measured with employment data.

Intra-industry spillovers are given by:

$$FPN1_{st} = \frac{\sum_{i \in Ms} X_{it}}{\sum_{i \in Gs} X_{it}} \qquad [A.1]$$

where X_{it} is employment of firm i at time t. Inter-industry spillovers are captured by the variables $FPN2$ and $FPN3$. The $FPN2$ variable measures vertical spillovers through forward linkages:

$$FPN2_{st} = \sum_{\substack{j \in S \\ j \neq s}} \alpha_{sjt} FPN1_{jt} \qquad [A.2]$$

with

$$\alpha_{sjt} = \frac{c_{sjt}}{\sum_{\substack{l \in S \\ l \neq s}} c_{slt}} \qquad [A.3]$$

where c_{sjt} denotes the weights of sector j in terms of acquisitions made by sector s, in each year t. These values are obtained from the input-output matrices provided by the Instituto Nacional de Estatística (INE).

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[11] At this aggregation level, this nomenclature is fully compatible with NACE-Eurostat.

FPN3 measures vertical spillovers through backward linkages as follows:

$$FPN3_{st} = \sum_{\substack{j \in S \\ j \neq s}} \eta_{sjt} FPN1_{jt} \qquad [A.4]$$

with

$$\eta_{sjt} = \frac{v_{sjt}}{\sum_{\substack{l \in S \\ l \neq s}} v_{slt}} \qquad [A.5]$$

where v_{sjt} denotes the weight of sector j in terms of the sales of sector s in year t.

Let us now define M_{sr} as the set of MNCs belonging to sector s and located in region r and G_{sr} as the set of all firms (domestic or foreign) belonging to sector s and located in region r. The variables that measure horizontal and vertical externalities through forward linkages and through backward linkages at the regional level, respectively *FPR1*, *FPR2* and *FPR3*, are given by:

$$FPR1_{rst} = \frac{\sum_{i \in Mrs} X_{it}}{\sum_{i \in Grs} X_{it}} \qquad [A.6]$$

$$FPR2_{rst} = \sum_{\substack{j \in S \\ j \neq s}} \alpha_{sjt} FPR1_{rjt} \qquad [A.7]$$

$$FPR3_{rst} = \sum_{\substack{j \in S \\ j \neq s}} \eta_{sjt} FPR1_{rjt} \qquad [A.8]$$

with X_{it} as before, α_{sjt} as given in [A.3] and η_{sjt} as given in [A.5].

Finally, let us define:

$$FPk_{it} = FPk_{st}, \, k = 1,2,3 \text{ and } FPk_{it} = FPk_{rst}, \, k = 4,5,6 \qquad [A.9]$$

with, s the index for the sector where firm i operates and r is the index for the region

where firm i is located.