



FDI spillovers at regional level: Evidence from Portugal*

Nuno Crespo³, Maria Paula Fontoura², Isabel Proença¹

¹ ISEG-Technical University of Lisbon and CEMAPRE (e-mail: isabelp@iseg.utl.pt)

² ISEG-Technical University of Lisbon and UECE (Research Unity on Complexity and Economics) (e-mail: fontoura@iseg.utl.pt)

³ ISCTE – Lisbon University Institute Portugal (e-mail: nuno.crespo@iscte.pt)

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Abstract. This paper aims to establish whether geographical proximity between multinational and domestic firms is relevant to the occurrence of FDI spillovers, by considering both horizontal and vertical spillovers. Using data for Portugal, this hypothesis is confirmed. In the case of horizontal externalities, the impact is negative, probably due to the competition effect. Concerning vertical externalities, a positive impact through backward linkages is observed. Additionally, omission of the regional dimension provokes a bias on the estimation of the intra-sectoral effect at the national level. These results raise important implications for the economic policies aiming to attract FDI and promote regional development.

JEL classification: F21, F23

Key words: Vertical spillovers, horizontal spillovers, multinational firms, productivity, FDI

1 Introduction

Foreign direct investment (FDI) is recognized today as one of the most vital motors for the stimulation of a country's development, and of real convergence with more developed economies. In addition to the direct effects of FDI, such as capital formation, job creation, increased tax revenues and transformation of the productive and export structures of the host countries, the attempts by countries to attract FDI are also motivated by the expectation of gaining access to more advanced technology. It is worth highlighting that the latter refers not only to the technical processes of production and distribution, but extends to management and marketing techniques (Blomström and Kokko 1998). Domestic firms can benefit from the superior technology possessed by a multinational company (MNC) through a variety of channels and, by so doing, achieve increased productivity. If these gains are not fully absorbed by the MNCs, FDI exter-

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nalities (spillovers) will be generated for domestic firms. These externalities may occur when the foreign firm and the domestic firm operate in the same sector (horizontal spillovers) and/or in different sectors vertically related (vertical spillovers).

The relevance of these types of effects for the host economy has inspired a vast body of studies seeking to investigate their existence and magnitude. The pioneering work was conducted by Caves (1974), but it was only in the 1990s that researchers increasingly turned their attention to this domain. However, the range of findings produced highly ambiguous conclusions.

Recent research on this question has shown that the phenomenon of spillovers will only occur among a sub-group of firms, with certain characteristics in common. Therefore, the results based on the 'global' effect, that is, the effect on the whole group of firms in the sample studied, could convey an incomplete view of the reality. Effectively, it seems clear today that the main way to conduct a research study into the existence of FDI spillovers for domestic firms is to focus on a detailed theoretical and empirical evaluation of the factors that determine the occurrence, the magnitude and the sign of the FDI externalities.¹

The objective of the present study is to pursue this line of research by analysing the importance of geographical proximity between domestic firms and MNCs in the occurrence of the phenomenon.

Using data at the firm level for the Portuguese manufacturing industry, the analysis simultaneously takes into consideration the horizontal and vertical spillovers. In fact, although some evidence has documented whether FDI spillovers have a regional dimension, very little is known about how the proximity between foreign and domestic firms affects the impact of vertical linkages on the productivity performance of domestic firms. To capture the magnitude of the external presence we consider a spatial unit specifically built for the purpose of our study.

The paper is organized as follows. Section 2 presents the main channels for the transmission of FDI externalities to domestic firms and provides a brief overview of the existing empirical evidence. Section 3 analyses the occurrence of spillovers in the case of Portugal. Finally, our concluding remarks are presented in Section 4.

2 FDI spillovers to domestic firms: Channels of transmission and empirical evidence

FDI spillovers can occur through five main channels: demonstration/imitation, exports, labour mobility, competition and backward and forward linkages with domestic firms (Halpern and Muraközy 2005; Crespo and Fontoura 2007a).²

Demonstration by MNCs/imitation by domestic firms is probably the most evident spillover channel (Das 1987; Wang and Blomström 1992). The introduction of a new technology may be too expensive and risky for the domestic firms, due to the uncertainty of the results that may be obtained. If that technology is successfully used by an MNC it may encourage the domestic firm to adopt it through imitation. The relevance of this effect increases if goods produced by the two firms are similar (Barrios and Strobl 2002).

Exports are a second possible channel for FDI spillovers. Several studies have highlighted the positive impact of an MNC on the export capacity of domestic firms (Rhee 1990; Aitken et al. 1997; Kokko et al. 2001). Export involves costs associated with the establishment of distribution networks, transport infrastructures or knowledge of consumers' tastes in foreign

¹ Chang et al. (2007) widen the discussion to consider the possible existence of spillovers from 'modernized' domestic firms to the remaining domestic firms.

² It is also possible that inward FDI is attracted by the purpose of gaining access to the technological advantages of the host country (Fosfuri and Motta 1999). However this possibility is not supported in the Portuguese case as the ratio between the efficiency level of the MNCs and the domestic firms is above 2 (Proença et al. 2006).

markets which MNCs are more able to afford. By following the export process of foreign firms (through imitation or, in specific circumstances, through collaboration), domestic firms may reduce the entry costs into the foreign market. The gains obtained in this way may have favourable repercussions on the productive efficiency of domestic firms (Bernard and Jensen 1999; Sgard 2001; Girma 2003; Greenaway et al. 2004).

A third channel is related to the possibility of domestic firms hiring workers who, having previously worked for an MNC, have knowledge and experience of the technology (Fosfuri et al. 2001; Glass and Saggi 2002; Görg and Strobl 2005). The influence of labour mobility on the efficiency of domestic firms is however difficult to evaluate, as it involves tracking workers in order to investigate their impact on the productivity of other workers (Saggi 2002). Nevertheless, it is important to stress a possible negative impact arising from this channel, as MNCs may attract the best workers from domestic firms by offering higher wages (Sinani and Meyer 2004).

The increased competition induced by MNCs is a fourth channel of FDI spillovers (Wang and Blomström 1992; Markusen and Venables 1999). Competition in the domestic economy between MNCs and domestic firms is, on the one hand, an incentive for the latter to make a more efficient use of existing resources and technology or even to adopt new technologies. On the other hand, the presence of MNCs may imply significant losses in (domestic) market shares, driving operation to a less efficient scale, with a consequent increase in average costs (Harrison 1994; Aitken and Harrison 1999).

A final channel concerns specifically the relationships that domestic firms establish in local markets as suppliers of MNCs (backward linkages) or customers of intermediate inputs produced by them (forward linkages), as pointed out, for instance, by Lall (1980), and formalized by Rodríguez-Clare (1996), Markusen and Venables (1999) and Lin and Saggi (2004).

Let us first consider the case of backward linkages. The presence of MNCs may benefit domestic suppliers if it increases the demand for local inputs in the presence of increasing returns to scale. Another possibility is apparently similar to the demonstration effect, but while in that case the foreign firms do not play an active role, now it is related to a direct relation between the MNC and the domestic suppliers. In this vertical relation, this particular effect occurs as the MNC induces the domestic suppliers to restructure in order to achieve the appropriate quality. Indeed, MNCs may lead domestic suppliers to assure a certain quality pattern in several ways: providing technical support for the improvement of the quality of goods or for the introduction of innovations (for instance, through labour training), providing support for the creation of productive infrastructures and for the acquisition of raw materials, as well as support at the organizational and management levels, among other aspects (Lall 1980; Driffield et al. 2004; Reganati and Sica 2005). Higher prices paid for the inputs may also increase productivity of domestic sellers, even if due to their better bargaining position, foreign firms might also be able to lower input prices, hence leading to lower productivity (Halpern and Muraközy 2005). Finally, a negative effect may also occur if foreign firms are not satisfied with the quality of suppliers and break away existing relationships (Yudaeva et al. 2003).

As far as the channel of forward linkages is concerned, the most evident link consists in 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). In some cases, MNCs may also benefit their domestic customers through a direct relation, by introducing them to new management techniques and production processes (Dunning 1993). Nevertheless, it is not possible to exclude another likely negative impact as the higher quality associated to the presence of the MNCs may lead to an increase in prices which penalizes domestic firms' costs (Javorcik 2004).

From the presentation above it is evident that the expected impact of the external presence on the productivity of domestic firms is ambiguous, as opposing effects are possible. Some authors have argued 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 at the intra-sectoral level and the efficiency gains are easier to obtain in backward-forward relations, due to greater incentive to cooperation (Kugler 2001).³

It has been suggested recently that FDI spillovers (both positive and negative) have a circumscribed geographical dimension or, at least, that they decrease with (physical) distance, as channels of technological diffusion are reinforced at the regional level (Audretsch and Feldman 1996; Audretsch 1998; Aitken and Harrison 1999; Sjöholm 1999; Ponomareva 2000; Girma and Wakelin 2001; Keller 2002; Girma 2003; Torlak 2004; Jordaan, 2005; Madariaga and Poncet 2007). Girma (2003) summarizes four reasons to expect that benefits to domestic firms from foreign investment would be confined to the locality of the investment. First, demonstration effects will be local, since the benefits are likely to be spread at least initially to neighbouring firms. Second, if a skilled worker leaves a foreign firm seeking work at a domestic firm, he is likely to prefer new employment in the same region. Third, MNCs may prefer local linkage industries in order to minimize transaction costs and facilitate communication with the domestic supplier/distributor. Fourth, the literature on economic geography suggests that knowledge externalities will be transmitted more effectively over small distances. Regional policies may also contribute to the importance of geographical proximity if they are concerned with maximizing the links between inward investors and domestic firms within their regions (Driffield 2006).

A substantial body of literature has been produced to analyse, at the empirical level, whether the presence of MNCs results in an increase of the productivity of domestic firms in host countries. However, most of these studies focus at the national level and are circumscribed to intra-sectoral spillovers; only recently, research on inter-sectoral spillovers has emerged (Barrios and Strobl 2002; Schoors and van der Tol 2002; Damijan et al. 2003; Yudaeva et al. 2003; Kugler 2006; Mullen and Williams 2007). Evidence on a regional effect is still very scarce.

Robust empirical evidence for FDI spillovers at the national scale is hard to find, as, for instance, the surveys by Görg and Greenaway (2004) and Crespo and Fontoura (2007a) show. In what concerns horizontal externalities, while pioneering evidence suggested a positive spillover effect, more recent studies, using econometric techniques that are more adequate point to heterogeneity on the spillover result, with many non-significant or even negative results.⁴ In a large sample of panel data studies with disaggregation at the firm level, Crespo and Fontoura (2007b) observe that in 59 cases, 31 point to a non-significant impact, 16 to a positive impact and 12 to a negative effect.⁵ The same ambiguity is present in the case of vertical externalities: with regard to backward linkages, Crespo and Fontoura (2007b) find seven studies with a positive sign, one with a negative sign and seven with non-significant results, while the three studies surveyed for forward linkages display a negative sign. Recently, Driffield et al. (2004) observe some (weak) evidence that inter-industry effects appear to be most noticeable where MNCs sell to domestic firms.

Recent literature on FDI spillovers stresses that it is possible that the expected effect is not observed at a more aggregate level (for all industries) but only in the case of a sub-set of firms/sectors, which display some common characteristics. However, empirical evidence does not

³ See also Harris and Robinson (2004) or Reganati and Sica (2005).

⁴ It is well known that the cross-sectional approach may induce significant bias in the estimation of the coefficients if there are unobserved time-invariant firm or specific effects on the relationship between the MNCs and productivity that are correlated with the explanatory variable of the model. Together with the fact that the development of domestic firms' productivity should be analysed over a long period of time and the improvement on panel data estimating techniques, this explains why most recent studies on the subject have opted for panel data models.

⁵ Proença et al. (2006) stress that some econometric problems inherent to the traditional panel data methods, may have produced a significant under-evaluation of spillover results.

allow definite conclusions for the majority of the possible determinant factors⁶ as it is basically inconsistent or still insufficient to produce unequivocal conclusions (Crespo and Fontoura 2007a). In spite of the strong arguments supporting the hypothesis that productivity spillovers may be geographically bounded, the existence of a regional effect is also an unsettled issue.

Most of the studies which consider the regional effect allow for horizontal spillovers only. This is the case for Sjöholm (1999), Aitken and Harrison (1999) and Yudaeva et al. (2003) with data for Indonesia, Venezuela and Russia, respectively, who do not confirm the relevance of a geographically limited area for the occurrence of the phenomenon, while 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 and 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 two recent papers by Halpern and Muraközy (2005) and Driffield et al. (2004), respectively for Hungary and the UK. The former finds (statistically significant) horizontal and backward FDI spillovers for domestic-owned firms at the national space but not at the regional one. The latter provides some evidence on the expected effect when domestic firms purchase from foreign firms.

Considering the few empirical attempts to assess FDI externalities on buyer-supplier relationships between foreign and domestic firms, a central contribution of this paper is to consider prospects for both horizontal and vertical FDI spillovers.

The lack of evidence on the regional effect can in part be related to the region defined for this purpose. In fact, most studies that investigate the possible existence of this effect have adopted, in spatial terms, the countries' administrative divisions as the only criterion for the definition of the regions.⁷ 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 geographically close. We define a spatial unit which in part overcomes the limitation of the administrative divisions.

3 Application to the Portuguese case

3.1 *The data and the model*

Taking the Portuguese case as reference for the empirical analysis, we propose, in this section, to test for the existence of inter- and intra-sectoral spillovers from FDI at a regional level defined as the county in which the domestic firm is located⁸ together with all of the directly neighbouring counties.⁹

⁶ Examples of these determinant 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 national origin from which the FDI emanates, the degree of foreign ownership of the MNCs' affiliates, the FDI entry mode, 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 or the FDI motivation.

⁷ The study of Halpern and Muraközy (2005) is an exception.

⁸ Mainland Portugal (which excludes the islands of Madeira and the Azores) is divided into 5 NUTS 2, 28 NUTS 3 and 275 counties.

⁹ It would be an interesting alternative exercise to capture the impact of physical distance through the Euclidian distances, as for instance in Bottazzi and Peri (2003) or Halpern and Muraközy (2005).

Table 1. Definition of the control variables

Variable	Definition
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 .
$H_{it} = \sum_{g \in J} \left(\frac{X_{gt}}{\sum_{g \in J} X_{gt}} \right)^2 \times 100$	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 value of 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 $1/H_{it}$.
AE_{it}	Degree of agglomeration – ratio between the employment in the region and the area of that region.

As is customary, the procedure used to test for the occurrence of FDI spillovers involves the evaluation of the magnitude of the influence of the external presence on the domestic firms' efficiency. With the proviso that labour productivity is a partial measure of overall multi-factor productivity, as assumed in many of the empirical studies in this area (see for instance Mullen and Williams 2007), if spillovers occur, there should be higher labour productivity levels for domestic firms in sectors with a larger foreign presence. The labour productivity of the domestic firm i , in the year t ($PROD_{it}$), defined as the total value added divided by the number of workers, is thus the dependent variable used, seeking to capture the efficiency of the domestic firms.

In addition to the variables intended to capture the influence of the dimension of the external presence,¹⁰ the set of explanatory variables contains various control variables (defined in Table 1) that may have influence on domestic firms' efficiency. In addition to the traditional determinants of productivity – skilled labour (SL), capitalistic intensity (CI), the degree of concentration of the sector to which the firm pertains (H) and scale economies (SE) – we include a variable to measure the so-called 'agglomeration economies' of the region where 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 is that the efficiency of each firm is higher if it locates in a region with a high degree of economic density (Ciccone and Hall 1996). This could be due to the concentration of suppliers, consultants, marketing arrangements, enlarged local pools of skilled labour, or specialized management.

Annual dummy variables to control for the productivity evolution of the Portuguese domestic firms are also included in the regression ($DI997$, $DI998$ and $DI999$).

The existence of FDI spillovers is tested by means of a set of variables that capture the dimension of the external presence. For this purpose and following the option adopted by, for example, Kokko (1994, 1996), Farinha and Mata (1996), Kinoshita (2001), Keller and Yeaple (2003), Girma (2003) or Karpaty and Lundberg (2004), we use data on employment.

We consider six variables related to the dimension of the external presence.¹¹ The variable FPI measures the weight of employment in the foreign firms in the total employment of the sector where the firm i operates, capturing the possible existence of horizontal spillovers at the national level. The occurrence of vertical spillovers at this level of analysis is tested through the variables $FP2$ and $FP3$. The variable $FP2$ captures the occurrence of vertical spillovers in the

¹⁰ See Wei and Liu (2004) for a comparison of alternative means of measuring the external presence.

¹¹ See Appendix 2.

case in which the foreign firms supply local firms (forward linkages). $FP2$ is a weighted average of the relative dimension of foreign presence in each sector (i.e., the FPI values) where the weight of each sector is given by the relative importance, for the sector where firm i operates, of the various supplying sectors (excluding the sector where firm i operates). $FP3$ is constructed by the same method, but this time with the focus on the relation in which the foreign firms are supplied by the local firms (backward linkages).

The importance of the regional effect in the occurrence of FDI spillovers is evaluated on the basis of three new variables: $FP4$, $FP5$ and $FP6$. Their construction follows the procedure described above with reference to FPI , $FP2$ and $FP3$ respectively, but now in the context of the regional geographical units obtained as explained earlier. Note that owing to data limitation, in order to build $FP5$ and $FP6$, we had to consider the same weights for inter-sectoral relations used for the variables at the national level ($FP2$ and $FP3$). Therefore we assume that these weights remain constant across regions.

It is reasonable to assume that the domestic firms need time to adjust to the foreign presence. To test this conjecture, we run the regressions with one-year lags for foreign presence, in a similar vein to most authors who opt for such a dynamic model (see, for instance, Driffield 2006).

To estimate the spillover effects, we have defined two types of model specifications, on the basis of whether or not the model includes the regional effect. The first model ignores the regional effect and is given by:

$$PROD_{it} = \beta_1 + \sum_{j=1}^3 \theta_j FP_{j_{it-1}} + \beta_2 SL_{it} + \beta_3 SE_{it} + \beta_4 CI_{it} + \beta_5 H_{it} + \sum_l \lambda_l D_{it} + \eta_i + \varepsilon_{it} \quad (1)$$

$$i = 1, \dots, n; t = 1996, \dots, 2000$$

where the variables FP_j ($j = 1, \dots, 3$), SL , SE , CI , H have the previously-mentioned significance and D_l ($l = 1997, \dots, 2000$) are the time dummies, η_i is the specific non-observed effect of the firm on productivity (constant through time), while ε_{it} represents the random error. Including the regional effect leads to:

$$PROD_{it} = \beta_1 + \sum_{j=1}^6 \theta_j FP_{j_{it-1}} + \beta_2 AE_{it} + \beta_3 SL_{it} + \beta_4 SE_{it} + \beta_5 CI_{it} + \beta_6 H_{it} + \sum_l \lambda_l D_{it} + \eta_i + \varepsilon_{it} \quad (2)$$

$$i = 1, \dots, n; t = 1996, \dots, 2000$$

where the variables have the meaning previously defined.

The analysis is based on two statistical sources embracing the period 1996–2000 and concerning the manufacturing industry: *Quadros de Pessoal* of the Ministry of Employment and Dun & Bradstreet.

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 establishments¹² employing wage-earners. In the period analysed, this dataset includes on average 26,428 manufacturing establishments and 822,733 workers. This statistical source allows us to build the crucial foreign presence variables (FP), as well as the control variable for the agglomeration effect (AE).

The data that we use from Dun & Bradstreet contains information on 1,303 Portuguese establishments for each of the years in the period studied, which enabled us to obtain a panel

¹² In fact, both statistical sources provide information for establishments, not for firms, either at the domestic or the foreign levels.

Table 2. Regional distribution of employment by counties – descriptive statistics

	Max.	Mean	Standard deviation
Manufacturing industry	46,160	2,978.8	5,933.5
Domestic firms	45,304	2,296.0	5,360.0
Foreign firms	15,604	414.3	1,123.3

Source: Own calculations based on *Quadros de Pessoal*, Ministry of Employment.

data comprising 6,515 observations. With reference to the foreign establishments operating in Portugal, the data available relates to 266 establishments in 1996, 262 in 1997, 300 in 1998, 322 in 1999 and 275 in 2000. This sample provides information about the geographical location (county) of the establishments and allows us to obtain PROD, SL, SE, CI and H, namely, the dependent and all the independent variables except AE and FP, as it provides information at the micro level.

Table 2, based on data from *Quadros de Pessoal*, presents some descriptive statistics about the regional distribution of employment by counties for manufacturing industry as a whole, considering the disaggregation between domestic and foreign firms. Table A1 in Appendix 1 disaggregates the first line of Table 2 by sectors.

Both domestic and foreign firms are mainly geographically concentrated on the western coast of the country, between Braga and Setúbal (with a particular concentration in the north and the Greater Lisbon area). For instance, the 16 counties with the highest share of foreign firms in the manufacturing industry are all located in that part of the country, while the 25 counties with the largest concentration of domestic firms are also situated in the same area.

The spatial distribution of the firms included in the Dun & Bradstreet sample is very similar to the pattern described above for *Quadros de Pessoal*, showing a significant concentration in the northern coast of the country and in the Greater Lisbon area. The sectoral distribution is also very similar with both sources, with sector 36 (which includes manufacturing n.e.c.) being a relevant exception. Table A2 shows some descriptive statistics regarding the information provided by this source.

Table A3 in the Appendix presents the descriptive statistics for the variables used in this paper.

3.2 Results

The estimation of Equations (1) and (2) are made with 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 heteroscedasticity (among firms) and to (unknown) autocorrelation.¹³ Although this method has been popularized for dynamic autoregressive models, it can be successfully applied to more general models to avoid estimation bias due to unobserved heterogeneity and/or simultaneity, which is the case in the present study. Indeed, we suspect that unobserved heterogeneous causes, which are constant in time and that influence productivity, depend on the explanatory variables in the model, and that the variables related to the dimension of the foreign presence in the same sector as the domestic firm (*FP1* and *FP4*), together with the skilled labour (*SL*), are endogenous. It is well known that high-productivity

¹³ The calculations were obtained with the *Stata*, using the *xtabond2* module developed by Roodman (2005) with Windmeijer correction.

sectors or firms may attract the location of MNCs in the same sector, yielding a positive relationship even without spillovers taking place, as emphasized by Aitken and Harrison (1999). Furthermore, it is highly plausible that workers' remuneration, the proxy for skilled labour, may also depend on productivity itself. On the other hand, the additional linear conditions proposed by the GMM system, 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.

Table 3 presents the results obtained. In all of the estimations, the Hansen test does not raise any doubts as to the validity of the instruments, while the Arellano and Bond tests do not reject

Table 3. FDI Spillovers for Domestic Firms: Estimation results

Independent variables	[1]	[2]	[3]	[4]
C	-1,429.81 (-0.98)	-2,745.91* (-1.84)	-1,170.63 (-0.77)	-881.53 (-0.48)
FP1	-3.80 (-0.08)	5.94 (0.16)	124.21* (1.77)	156.25** (2.11)
FP2		9.14 (0.45)	-19.77 (-0.82)	4.51 (0.19)
FP3		73.57*** (2.95)	-25.61 (-0.67)	-19.34 (-0.56)
FP4			-173.70** (-2.40)	-185.29*** (-2.76)
FP5			50.71 (1.64)	1.07 (0.03)
FP6			83.01* (1.82)	72.44 (1.63)
AE			-4.50 (-1.12)	-277.04 (-1.12)
SL	1.49*** (9.89)	1.49*** (10.91)	1.46*** (10.56)	1.45*** (9.89)
SE	27.82** (2.42)	24.72** (2.20)	22.77** (2.17)	22.18** (1.91)
CI	0.13*** (4.42)	0.14*** (4.64)	0.13*** (4.61)	0.14*** (4.74)
H	106.44 (0.75)	-19.83 (-0.17)	3.28 (0.02)	15.33 (0.10)
D1997	1,035.84** (2.54)	1,057.85*** (2.75)	831.55** (2.08)	1,037.69** (2.50)
D1998	1,153.66*** (3.72)	1,080.85*** (3.68)	1,097.06*** (3.70)	1,075.28*** (3.50)
D1999	546.26*** (2.82)	556.27*** (3.07)	532.72*** (3.07)	451.81*** (2.53)
Hansen test (p-value)	29.60 (0.077)	21.84 (0.384)	26.68 (0.536)	37.21 (0.114)
Arellano-Bond test				
for AR(1)	-1.03	-1.03	-1.03	-1.04
(p-value)	(0.304)	(0.304)	(0.301)	(0.300)
for AR(2)	-0.66	-0.67	-0.69	-0.68
(p-value)	(0.507)	(0.506)	(0.461)	(0.497)
No. of observations (nr. of firms)	6,515 (1,303)	6,515 (1,303)	6,515 (1,303)	6,515 (1,303)

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

the absence of autocorrelation. With regard to the control variables, the results show that capitalistic intensity (CI), skilled labour (SL) and scale economies (SE) have a significant impact on labour productivity. The measure of agglomeration economies (AE) does not confirm the importance of the dimension of manufacturing activity within a region for productivity improvements in domestically-owned firms.

Columns [1] and [2] of Table 3 adopt the entirety of the country as the spatial scale of evaluation. In column [1], only the occurrence of horizontal spillovers is tested. It corresponds to the most frequently used specification in the analysis of the existence of FDI spillovers for domestic firms, thus enabling a direct comparison with the ample evidence already produced in this domain. Therefore, in column [1], only *FPI* is considered, the effect of spillovers being measured by θ_1 . The fact that *FPI* is not significant is, as we highlight in Section 2, consistent with the prevailing evidence in the body of studies that have used panel data.

Column [2] expands the evaluation of the FDI externalities so as to include, simultaneously, variables aiming to capture the horizontal and vertical spillovers, while maintaining the country as the geographical unit of analysis. In this case, the equation contains the variables *FPI*, *FP2* and *FP3*, θ_1 to measure the horizontal effect, while θ_2 and θ_3 measure the vertical effects. The results obtained suggest the occurrence of a positive and significant inter-sectoral effect, benefiting the domestic firms by means of backward linkages.

After having evaluated the existence of FDI spillovers with variables defined at the national space, we now turn our attention to the equation that incorporates variables constructed at the regional scale previously defined (Equation 2). Hence, in addition to the spillovers at the national level (measured by θ_1 , θ_2 and θ_3), the spillover effects are evaluated at this regional level (measured by θ_4 , θ_5 and θ_6). Column [3] of Table 3 reports the results obtained.

The evidence in relation to column [3], compared to columns [1] and [2], clearly demonstrates not only the importance of the regional effect in the occurrence of spillovers, but also that its omission may provoke severe bias in the estimation of the national effect. Indeed, horizontal FDI externalities are now observed both at the national and regional levels but with opposing signs, indicating that in column [1], a negative effect at the regional level was annulling the positive effect at the national level.

Still with regard to the horizontal spillovers, the negative impact of the presence of MNCs presented in column [3] is probably due to the negative influence of the competition channel being more accentuated at regional level. It is possible that this is a short-term effect (Sembenelli and Siotis 2005) and that this adverse effect may be offset in the long term through an overall increase in allocative efficiency and through balance of payments gains (Driffield 2004), but in any case, it is suggestive of a crowding-out effect exerted by inward investors on domestic firms at the regional level.

Concerning vertical spillovers, there is evidence of a positive and significant inter-sectoral effect by means of backward linkages at the regional level, while this effect is no longer significant at the national level. This finding shows that the buyer relationship between foreign manufacturers and their domestically-owned counterparts as a driver of indirect economic benefits is geographically limited. For its part, the neutral impact through forward linkages is in line with most previous studies, suggesting that the foreign suppliers were not concerned with building local networks.

In order to have a clearer picture on the impact of physical distance and to allow a more direct comparison with other similar studies, we also consider a larger spatial unit defined by the administrative region known as NUTS 2. The results are presented in column [4]. Comparing with column [3], the findings are qualitatively very similar for both spatial units, with one exception: the backward linkages are no longer significant at this larger regional level. Considering that also at the national level, these backward effects are not observable, the message is

Table 4. FDI spillovers for domestic firms: Qualitative results

Types of spillovers		Geographical level					
		National	National	National + regional I		National + regional II	
				National	Regional	National	Regional
Horizontal		n.s.	n.s.	+	–	+	–
Vertical	Backward		+	n.s.	+	n.s.	n.s.
	Forward		n.s.	n.s.	n.s.	n.s.	n.s.

Notes: Regional I: county and directly neighbouring counties. Regional II: NUTS 2.

clearly that only for limited geographical distances do foreign buyers generate efficiency benefits for the domestic-owned firms.

Table 4 summarizes the qualitative results concerning the variables built to capture the spillover effect (FP).

Finally, we have controlled for the possibility that the agglomeration effect would be more adequately captured through the number of firms per km². However, our findings do not give support to this hypothesis, since the results for all the variables are very similar with both proxies.

4 Concluding remarks

The analysis which has been conducted in this paper has allowed us to confirm the decisive importance of considering the geographical proximity between MNCs and domestic firms in relation to the occurrence of FDI spillovers. The fact that the positive intra-sectoral effect at the national level is observed only when the model is extended to the regional level suggests that estimates of FDI spillovers that do not allow for the regional dimension must be treated with caution.

Additionally, the existence of inter-sectoral externalities at the regional level emphasizes the importance of giving more attention to these relations in similar studies for other countries.

The set of results obtained suggest certain messages of relevance to economic policy.

First, the importance of geographical proximity to the occurrence of FDI spillovers underlines that both the national and regional authorities are presented with the task of creating conditions favourable for FDI.

In the Portuguese case, only projects of less importance are financed by the system of regional incentives, which basically consist of land at very low prices, together with fiscal incentives aiming to attract foreign firms to unfavoured areas of the country, the extent of which depends upon the number of persons employed. However, the evidence presented shows that there is clearly a role for local agencies in encouraging inward foreign investment.

Attention should be given, nevertheless, to the possibility that the occurrence of FDI spillovers may also be conditioned by the absorptive capacity of the region where the firms operate. In fact previous evidence (for instance, Imbriani and Reganati 1999, for Italy; and Sgard 2001, for Hungary) shows that FDI externalities mostly benefit firms located in the most developed regions. An interesting research avenue for the Portuguese case would be to cross the two geographical dimensions of FDI spillovers: the proximity between domestic and foreign firms and the development level of the different regions.

Second, the evidence at the regional level of negative intra-sectoral effects and positive effects only where foreign manufacturing buys from domestic manufacturing highlights the conception of policies prioritizing FDI. In the case of Portugal, local incentives do not appear to have produced a marked impact (Freitas et al. 2005). However, the results obtained suggest that it may be beneficial to promote tax holidays and other subventions that stimulate foreign firms to set up plants in the same place as vertically related domestic firms, either to disseminate new technologies in the buying relationships from foreign to domestic manufacturing or to stimulate the emergence of new linkages with domestic buyers. On the other hand, the negative link between domestic and foreign firms operating in the same sector and located in close geographical proximity to each other constitutes a factor that should not be overlooked. Indeed, it questions the extent to which incentives to foreign manufacturing investment in the same sector as domestic firms can contribute to regional development beyond the direct employment effects, since such effects may contribute to a short-term loss in the productivity of domestic firms, due to a reduction in scale of the domestic sector.

Naturally, much work remains to be carried out in order to expand knowledge of the impact of the MNCs' presence on the efficiency of domestic firms. More progress might be possible in assessing inter-regional effects if we had the weights for inter-sectoral relations by region. A deeper analysis of other conditioning factors of FDI spillovers could also be particularly valuable, with a view to checking the robustness of our results and to determine, with greater accuracy, the concrete circumstances which facilitate or inhibit the manifestation of this phenomenon, drawing from this the appropriate consequences in terms of attracting FDI and promoting regional development. Finally, future research should replicate this analysis with regard to other countries in order to confirm the robustness of our empirical conclusions.

Appendix 1. Descriptive statistics

Table A1. Descriptive statistics on regional distribution of employment by counties

Sector	Max.	Simple average	Standard deviation
15	3,767	312.7	528.7
16	578	2.7	36.0
17	22,339	382.9	1,850.9
18	10,095	433.6	1,258.1
19	10,998	235.1	1,154.7
20	9,489	151.0	595.5
21	1,321	47.3	162.5
22	8,087	108.4	578.4
23	1,010	4.6	62.0
24	2,573	80.2	276.9
25	2,232	70.5	206.7
26	4,626	229.7	575.1
27	1,170	33.8	129.1
28	4,354	235.0	560.1
29	2,372	140.4	375.6
30	25	0.3	2.0
31	5,264	102.1	461.0
32	3,827	49.4	289.6
33	1,064	18.6	102.3
34	4,415	70.6	335.9
35	2,114	44.4	212.0
36	4,576	141.7	451.9
37	61	1.8	7.6
Manufacturing industry	46,160	2,978.8	5,933.5

Notes: 15 – Manufacture of food products and beverages; 16 – Manufacture of tobacco products; 17 – Manufacture of textiles; 18 – Manufacture of wearing apparel; dressing and dyeing of fur; 19 – Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear; 20 – Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and painting materials; 21 – Manufacture of pulp, paper and paper products; 22 – Publishing, printing and reproduction of recorded media; 23 – Manufacture of coke, refined petroleum and nuclear fuel; 24 – Manufacture of chemicals and chemicals products; 25 – Manufacture of rubber and plastic products; 26 – Manufacture of other non- metallic mineral products; 27 – Manufacture of basic metals; 28 – Manufacture of fabricated metal products, except machinery and equipment; 29 – Manufacture of machinery and equipment n.e.c.; 30 – Manufacture of office machinery and computers; 31 – Manufacture of electrical machinery and apparatus n.e.c.; 32 – Manufacture of radio, television and communication equipment and apparatus; 33 – Manufacture of medical, precision and optical instruments, watches and clocks; 34 – Manufacture of motor vehicles, trailers and semi-trailers; 35 – Manufacture of other transport equipment; 36 – Manufacture of furniture; manufacturing n.e.c.; 37 – Recycling.

Source: Own calculations based on *Quadros de Pessoal*, Ministry of Employment.

Table A2. Dun & Bradstreet sample: Some descriptive statistics

Variable	Max.	Simple average	Standard deviation
Value added	256,204,000	3,753,778	9,818,767
Total wages	44,785,200	1,945,422	3,663,276
Total fixed assets	1,128,810,000	13,192,500	46,989,900
Number of workers	2,500	147	213
Production	550,950,000	12,851,700	32,611,200

Source: Own calculations based on *Dun & Bradstreet*.

Table A3. Variables of the model: Descriptive Statistics

Variable	Max.	Simple average	Standard deviation
PROD	423,027.72	23,691.79	23,195.20
FP1	0.8204	0.1403	0.1372
FP2	0.4321	0.1975	0.0771
FP3	0.5613	0.2148	0.1183
FP4	0.9061	0.1302	0.1390
FP5	0.5124	0.1577	0.0830
FP6	0.6673	0.1917	0.1237
AE	3.6558	2.7069	0.9964
SL	156,304.44	12,407.58	7,693.81
SE	6.5691	0.3644	0.5738
CI	2,036,524.25	23,568.83	124,036.15
H	0.3063	0.0411	0.0400

Source: Own calculations based on *Dun & Bradstreet* and *Quadros de Pessoal*, Ministry of Employment.

Appendix 2. The variables FP

Consider S the set of all sectors of the economy. In this study, sectors are considered at the two-digit level of the CAE – revision 2, with respect to the manufacturing industry (sectors 15 to 37).¹⁴ Define M_s and G_s respectively, the set of the MNCs belonging to sector s and the set of all firms belonging to this sector. Foreign presence is measured with employment data. Therefore, horizontal spillovers at the domestic level are given by:

$$FPI_{st} = \frac{\sum_{i \in M_s} X_{it}}{\sum_{i \in G_s} X_{it}} \quad (\text{A.1})$$

where X_{it} is employment of firm i at time t . Vertical spillovers are measured by the variables $FP2$ and $FP3$. The $FP2$ variable measures vertical spillovers through forward linkages as follows:

$$FP2_{st} = \sum_{\substack{j \in S \\ j \neq s}} \alpha_{sjt} FPI_{jt} \quad (\text{A.2})$$

with

$$\alpha_{sjt} = \frac{c_{sjt}}{\sum_{\substack{l \in S \\ l \neq s}} c_{slt}} \quad (\text{A.3})$$

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 sourced by the Instituto Nacional de Estatística (INE).

¹⁴ At this level of aggregation, this nomenclature is fully compatible with NACE-Eurostat.

The $FP3$ variable measures vertical spillovers through backward linkages as follows,

$$FP3_{st} = \sum_{\substack{j \in S \\ j \neq s}} \eta_{sjt} FPI_{jt} \quad (\text{A.4})$$

with

$$\eta_{sjt} = \frac{v_{sjt}}{\sum_{\substack{l \in S \\ l \neq s}} v_{slt}} \quad (\text{A.5})$$

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 the MNCs belonging to sector s 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 vertically externalities through forward linkages and through backward linkages at the regional level, respectively $FP4$, $FP5$ and $FP6$, are given by

$$FP4_{rst} = \frac{\sum_{i \in M_{rs}} X_{it}}{\sum_{i \in G_{rs}} X_{it}} \quad (\text{A.6})$$

$$FP5_{rst} = \sum_{\substack{j \in S \\ j \neq s}} \alpha_{sjt} FP4_{rjt} \quad (\text{A.7})$$

$$FP6_{rst} = \sum_{\substack{j \in S \\ j \neq s}} \eta_{sjt} FP4_{rjt} \quad (\text{A.8})$$

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

Finally, let us define,

$$FPk_{it} = FPk_{st}, \quad k = 1, 2, 3 \quad \text{and} \quad FPk_{it} = FPk_{rst}, \quad k = 4, 5, 6 \quad (\text{A.9})$$

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

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