Manufacturing Productivity and FDI Externalities: is Small Beautiful?

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Abstract- The role of FDI as a vehicle for economic growth is debatable in practice. On the other hand, the size of the company and the technological groups can influence the occurrence and magnitude of FDI externalities. Thus, this article investigates the impact of firm size on the occurrence of foreign direct investment externalities in the Portuguese industry from 1995 to 2007, by technology groups, using panel data at the firm level. To this end, we estimate the TFP and regress it on a set of variables, including the foreign presence in the same sector, upstream and downstream. The results show that only (small and large) companies in scale-intensive industries; and small firms in science-based industries benefit from the positive externalities of FDI. This suggests that firm size can influence the occurrence of FDI externalities in the manufacturing sector, but only in some technology groups. Based on the results, investment policy recommendations are made.

Key-Words: Foreign Direct Investment, Firm Size, Externalities, Manufacturing.

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1 Introduction

FDI can be an essential vehicle for economic growth [1-2]. However, the role of FDI as a vehicle for economic growth is a less debatable assumption in theory than in practice [3]. In particular, the issue of whether FDI contributes to the increase of the Total Factor Productivity (TFP) in manufacturing is of particular importance, since Portugal is a small open economy facing restrictions arising from the economic crisis that slowed down the productivity growth. Thus, we investigate the existence of externalities from FDI in Portuguese manufacturing, aiming to assist industrial policy in choosing the appropriate measures to promote the occurrence of externalities, either in the same industry (horizontal externalities) or in upstream/downstream industries (vertical externalities). However, one cannot reject the possibility that externalities occur because the initially more productive domestic firms attract more foreign capital. Therefore, we employ panel data from the AMADEUS database for firms of all sizes over the period 1995-2007 to ensure that firms with different levels of (TFP) are evenly distributed in the sample. The time span of 13 years allows for the study of dynamic effects since previous empirical literature finds that externalities need 2 years to materialize.

The choice of the estimator depends on the data and the underlying assumptions. Following Wooldridge [4] and Levinsohn & Petrin's [5] procedure, we use a control function approach that employs intermediate inputs as the proxy for unobserved productivity, this procedure has the advantage of retaining a higher number of observations than the Olley and Pakes [6] approach because intermediate inputs are always positive (at least in my database). In a second stage, within a growth-accounting framework, we estimate the impact of FDI on the TFP growth, using the system GMM (Sys-GMM) estimator proposed by Arellano and Bover [7] and Blundel and Bond [8]. In addition, we cluster the industries by technological groups according to an adaptation of O'Mahony e Van Ark [9] and Bogliacino and Pianta [10] of Pavitt's taxonomy. Thus, firms in scale-intensive industries (NACE rev. 2 codes 10, 11, 12, 19, 22, 23, 24, 25, 29, and 30) are large and their main source of technology relies on the production engineering of their suppliers and R&D; Firms in science-based industries (NACE rev. 2 codes 20, 21, 26 and 27) are characterized by relatively large size and produce roughly the same share of process and product innovations. The sources of process innovations are internal and external (from suppliers); In supplier-dominated industries (NACE rev. 2 codes 13, 14, 15, 16, 17, 18 and 31) firms are characterized by relatively small size, limited resources regarding engineering and internal R&D and rely on suppliers to innovate; finally, in specialized-suppliers industries (NACE rev. 2 codes 28, 32 and 33), firms are relatively small and the consumers are sensitive to their performance. We make several contributions to the literature on externalities from FDI. First, we investigate the existence of both horizontal and vertical externalities from FDI in Portugal. Second, we use lags in the measures of foreign presence to account for the time lapse required for externalities to materialize. Third, we break down the results across industries along their trajectories of technological change which allows uncovering some interesting patterns. Indeed, the technological groups that benefit more from foreign presence are scale-intensive and science-based industries.

This paper is organized as follows. Section 2 reviews the Literature; Section 3 analyses FDI flows and stocks in manufacturing; section 4 describes data and methodology; Section 5 reports the results; Section 6 discusses de result; and section 7 concludes.

2 Empirical Literature

Panel studies, at the firm level, include [11-14]. Farinha and Mata [11] analyzed the 1986-1992 period while Proença et al. [12] focused their analysis between 1996 and 1998, and Crespo et al. [13-14] analyzed the period 1996-2001. Except for Farinha and Mata [11], which use a random-effects model, all authors use the sys-GMM to regress the labor productivity on the level of foreign presence (whose proxy is the employment in foreign firms, except Proença et al. [12] that use the capital stock). Data sources are Dun & Bradstreet and Quadros de Pessoal, except Farinha and Mata [11] that also use data from Banco de Portugal.

The present study is the most comprehensive for Portugal, regarding time (1995-2007) and sample size (65,585 observations). In addition, until now, only Crespo et al. [13-14] have investigated the existence of vertical externalities in Portugal. Moreover, there are no studies for 2001-2007 and the results for 1996-2000 are controversial. Indeed, regarding horizontal externalities, while Crespo et al. [14] find negative results, for 1996-2001; Proença et al. [12,15] find no significant results for 1996-1998, and Crespo et al. [13] find negative results for 1996-2000. Finally, Crespo et al. [14] find evidence of positive vertical externalities (via backward linkages) for 1996-2001, but only at a regional level. One possible cause for these controversial results may be the underestimation of the externality effects due to econometric problems associated with traditional panel data estimation methods, as highlighted by Proença et al. [15]. In addition to different results for the same period, hitherto researchers tested the impact of a few determinant factors of FDI externalities, i.e., the technological gap/absorptive capacity and the geographical proximity between MNCs and domestic firms. Given the lack of consensus in these studies, we analyze the occurrence of both horizontal and vertical externalities in the manufacturing firms from 1995 to 2007. The results will enable policymakers to identify the industries that benefit more from the foreign presence and to implement relevant policies to leverage positive externality effects.

3 FDI in the Manufacturing

During the 1990s, the industrial policy in Portugal focused on attracting foreign capital, mostly through privatizations, but also by offering Government and EU subsidies and assistance to investors. Although, FDI inflows represented only 5.7% of GDP over this period, in 2007, foreign capital stocks represented nearly 50% of GDP.

Though the Portuguese accession to the European Economic Community (EEC) in 1986 encouraged the increase of FDI flows; in the 1990s there was a sharp decline compared to the previous decade due to adverse factors, namely the instability of interest and exchange rates, the slowdown of the privatization program and the end of the full exploitation of single market investment opportunities. The value of flows in 1995-1999 ranged from $660 million to $3,005 million. From 2000 to 2007, there was a large fluctuation in FDI flows. From 2000 to 2001, the trends in mergers and acquisitions (M&As) caused a boom in FDI flows at a global level [16]; with Portugal attracting over $6 billion. However, in the following year, the rise of oil prices caused a drop in the flows of FDI directed to Portugal to $1,801 million. In 2003 there was an increase to $7,155 million, and then a sharp decrease in the following years. According to OECD [17], in 2006 the global economy grew faster and thus, FDI flows recorded the highest peak of $10,914 million. However, in 2007 this amount was reduced by more than half, standing at $ 3,063 million. In that year, according to UNCTAD, Portugal occupied the 29th position worldwide in terms of FDI attraction, which was above that of several Eastern European countries such as the Czech Republic and Hungary. Given the peripheral location and the weaknesses that Portugal presents at the aggregate level, namely the low productivity, low educational level, and low R&D expenditures, which are prone to cause disadvantages when competing with other low-cost labor destinations, this represented a major achievement. Nevertheless, according to the OECD database, from 1995 to 2007, Portugal attracted, on average, only 0.7% of global FDI flows. In this context, the importance of the manufacturing concerns the technology transfer from MNCs to local firms, due to its high innovation indices and potential indirect and induced impacts on other sectors through "pull" and "push" effects.

In 1995, the manufacturing sector ranked first relative to other economic sectors capturing 40% of FDI flows. In the following years, due to the domestic economic crisis, its importance in attracting flows decreased, and there were disinvestments in 1998-1999, 2001-2002, 2005, and 2007. This may be attributed to the worldwide reorganization of labor-intensive manufacturing industries towards fragmented production systems taking advantage of cost differentials of Central and Eastern European countries (CEECs). However, in 2004, the flows to manufacturing grew exponentially compared to 2003, reaching a peak that represented nearly half of total FDI inflows to Portugal. In the years 1996-1998; 2002-2003 and 2005-2007, the preferred industries by foreign investors were chemicals and rubber, and plastics. From 1999 to 2000, foreign firms targeted the textiles, clothing, and footwear industries. In 2001, most foreign capitals was directed to machinery and equipment industries; and in 2004, to electric and optical equipment. Textiles ranked second, in the years 1996-1998 and 2003; and machinery and equipment ranked second in the years 2002 and 2005- 2007. In 2004 the industries of food, beverages, and tobacco ranked second in foreign investors' preferences.

4 Methodology

Data for the Portuguese manufacturing firms in 1995-2007 come from AMADEUS database. The balanced panel data set includes 5,045 manufacturing firms of all sizes (4,685 domestic and 360 foreign) for the 13 years in a total of 65,585 observations. The regression analysis, however, includes only 51,535 observations since the rest of the observations dropped due to collinearity. Table 1 shows some basic statistics.

Firms with foreign capital represent 7% with a mean share of foreign capital of 58%. There are 12 Greenfield projects in 9 industries. The rest of the foreign firms correspond to Mergers & Acquisitions (M&As). Since foreign firms are more productive than their domestic counterparts, we will analyze the occurrence of productivity externalities from foreign firms to domestic firms. Using the WLP (09) procedure to address endogeneity in capital and the possibility of productivity shocks, we estimate the level of TFP, departing from the following equation

$$Y_{ijt} = A_{ijt} K_{ijt}^{\beta k} L_{ijt}^{\beta l} M_{ijt}^{\beta m} \quad (1)$$

where Yijt represents the physical output of firm i in sector j and period t, Kijt, Lijt and Mijt are the inputs of capital, labor, and materials, respectively. Aijt is the Hicksian neutral efficiency level (my concept of total factor productivity – TFP) of firm i in period t. For a given level of A, higher output levels demand higher inputs (K, L and M) levels.

We assume that $L = L^P + L^{NP}$, where L^P stands for production worker (unskilled) labor and L^{NP} stands for non-production worker (skilled) labor. we proxy L^{NP} by the sectoral average of years of schooling since we do not possess information for individual firms. A_{ijt} is not observable and needs to be estimated.

Table 1. Summary statistics

Total number of firms	5,045
Fully domestic firms	4,685
Firms with foreign share	360
Mean (domestic firms)	
TFP	5,152
Capital	2,657,802
Labor	34
Mean (foreign firms)	
TFP	7,691
Capital	1,162,430
Labor	24

Source: Author's calculations on Stata 13.0

The estimation of A_{ijt}, depends on several different components such as skills, knowledge and firm-level capabilities, including managerial and organizational competences. we assume that A_{ijt}, or TFP in logs, is given by:

$$\ln(A_{ijt}) = \beta_0 + \varepsilon_{ijt} \quad (2)$$

where β_0 measures the mean efficiency level across firms over time; ε_{ijt} is the time- and producer-specific deviation from that mean. Taking natural logs of (1) and inserting equation (2) we obtain a linear production function

$$y_{ijt} = \beta_0 + \beta_k k_{ijt} + \beta_{lP} l^P_{ijt} + \beta_{lNP} l^{NP}_{ijt} + \beta_m m_{ijt} + \varepsilon_{ijt} \quad (3)$$

where lower cases refer to natural logarithms.

The error term ε_{ijt} can be further decomposed into an observable (or at least predictable); and an unobservable i.i.d. component, representing unexpected deviations from the mean due to measurement error, unexpected delays, or other external circumstances, i.e, $\varepsilon_{ijt} = v_{ij} + u^q_{ijt}$. Hence, equation (3) becomes

$$y_{ijt} = \beta_0 + \beta_k k_{ijt} + \beta_{lP} l^P_{ijt} + \beta_{lNP} l^{NP}_{ijt} + \beta_m m_{ijt} + v_{ijt} + u^q_{ijt} \quad (4)$$

Since the firm-level productivity is $tfp_{ijt} = \beta_0 + v_{ijt}$; and rearranging the terms of (2) we obtain

$$tfp_{ijt} = y_{ijt} - (\beta_k k_{ijt} + \beta_{lP} l^P_{ijt} + \beta_{lNP} l^{NP}_{ijt} + \beta_m m_{ijt}) - u^q_{ijt} \quad (5)$$

And the estimated productivity is

$$\hat{tfp} = tfp_{ijt} + u^{q}_{ijt} \tag{6}$$

Defining the value added as $va_{ijt}=y_{ijt}-\beta_m m_{ijt}$, then it can be estimated through equation (4) as a residual

$$\hat{tfp}_{ijt} = va_{ijt} - (\hat{\varepsilon}^{v}_{jP}\ l^{P}_{ijt} + \hat{\varepsilon}^{v}_{jNP}\ l^{NP}_{ijt} + \hat{\varepsilon}^{v}_{jK}\ k_{ijt}) \tag{7}$$

The growth of the estimated TFP is regressed on a set of variables, within a fixed effects dynamic model**,** including a time trend. The three sets of variables are described as follows.

Variables related to foreign presence. Externalities from FDI may be horizontal or vertical. Horizontal externalities occur when the entry of the MNC generates positive externalities for local competitors. Vertical externalities occur when the links between MNCs and their local suppliers/customers (backward/forward linkages) generate positive externalities. Hence, we measure the foreign presence through three variables *hor, back* and *for* defined at sectoral level. Horizontal technology transfer occurs through contact with local competitors (via demonstration/imitation, labor mobility, exports, competition, consulting and specialized services, and coordination with local institutions). *hor* is a sectoral externality variable that measures the share of output by foreign firms in the total output of the industry, i.e., measures the presence of FDI on a given industry and is calculated in the following way

$$hor_{jt} = \frac{\sum_{i} \quad foutput_{it}}{\sum_{i\in j} \quad output_{it}} \tag{8}$$

where $foutput_{it}$ is the output of firms with foreign capital operating in industry *j* at time *t*. Thus the value of the variable increases with the output of foreign firms. Hirschman [18] stated that a lack of linkages in the developing economy leads to a lack of industrial development. From a developmental perspective, it is generally assumed that linkages between MNCs and domestic firms are better than no linkages, and the more and deeper linkages are, the better it is for the host economy [19-20]. MNCs in other industries appeared to foster broad linkages in the host economy by creating industries that supply the MNC and by inducing forward industries to use the multinational's output as inputs, the crowding-in effect of FDI [21]. The variable *hor* measures the presence of FDI in a given industry, then the higher its value the greater the increase in domestic firms' productivity. Thus, following Barrios and Strobl [22] 2002 we expect a positive effect on domestic firms' TFP growth. Vertical externalities occur when an MNC increases the demand for local inputs, leading to increased specialization in upstream sectors and, as a result, causing the reduction of costs in downstream sectors. If the MNCs are interested in maintaining the quality standards they are likely to provide technical support to local suppliers in order to improve the quality of inputs, or assist them in the introduction of innovations, training, creation of productive infrastructure, procurement of raw materials, as well as the introduction of new management techniques, among others [23]. Vertical technology transfer occurs through linkages with local suppliers (backward linkages) or local customers (forward linkages). We define *back* as

$$back_{jt} = \sum_{k\neq j} \quad \delta_{jk} * hor_{kt} \tag{9}$$

where δjk is the share of industry j's output supplied to industry with foreign presence *k*. The variable *back* is intended to capture the effect that multinational customers have on domestic suppliers. Both *j* and *k* are two-digit industries.

Forward linkages occur when the MNCs provide higher quality and/or cheaper inputs to their clients that produce final goods [24]. Better quality inputs supplied by foreign firms may increase the productivity of domestic firms in industry *j*. Similarly, we define *for* as

$$for_{jt} = \sum_{k\neq j} \quad \lambda_{kj} * hor_{kt} \tag{10}$$

where λ_{kj} is the share of inputs that industry *j* buys from industry k. The variable captures the contacts between domestic firms and their foreign suppliers. Parameters δ and λ are obtained from the OECD Input-Output (IO) Tables. We exclude the diagonal elements of the IO tables in the calculation of the weighted average because intrasectoral effects are accounted for in the variable *hor*. Moreover, we focus on inputs for intermediate consumption; therefore, we do not include the imports, exports, or other components of final demand in the calculation of the IO coefficients. As highlighted by [25], the net effect of linkages can either be positive or negative when domestic suppliers serve the MNCs exclusively. Indeed, under these circumstances, the technology transferred to domestic suppliers increases but the reduction of the rivalry among domestic suppliers tends to reduce the aggregate output level of the intermediate goods industry. In addition, a decrease in the cost of inputs compatible with the foreign technology, while benefiting foreign firms and the most productive downstream domestic firms adopting the foreign technology, it negatively affects firms using the domestic technology [26]. However, we assume that the higher the value of *back* and *for*, the greater the magnitude of vertical externalities and thus the greater the effect on the TFP growth of domestic firms. The increase in demand for high-quality inputs by MNCs or due to the purchase of better-quality inputs provided by foreign firms [23-24]. Hence, following Markusen and Venables [24] we expect a positive coefficient for variables *back* and *for*.

Control variables. We include six control variables; *hfd* is the Herfindhal index that measures market concentration, *rd* is the value of R&D expenses proxied by firms' intangible assets, *mrdf* is the average value of sectoral foreign R&D expenditure, *s* measures the scale of operations, *tg* is the technological gap, and *kl* measures the capital intensity.

Concentration. The Herfindhal index indicates market concentration and is calculated as

$$H_{it} = \sum_{g \in J} \left(\frac{X_{gt}}{\sum_{g \in J} X_{gt}} \right)^2 * 100 \qquad (11)$$

where X represents the output of firm g (domestic or foreign) belonging to sector j, at time t. The output is proxied by firm turnover obtained from AMADEUS database, deflated by a Producer Price Index. The Herfindahl index also serves as a proxy of (the lack of) competition. Indeed, since this variable is calculated as a share (%), values close to 0 indicate markets under perfect competition, and a value of 100 denotes the presence of monopoly rents. If the impact of the variable *hfd* on the TFP growth is positive, it means that the market power can facilitate access to the necessary resources for domestic firms to increase their productivity. Indeed, stronger industry concentration generates larger profits that can be re-invested, for example, in new technologies or in the production of more sophisticated products; however, if the sign is negative, it implies that the monopolistic inefficiencies are causing a decrease in the rate of innovation [27] and, thus, a loss of productivity. As a result, the expected sign of this variable is not predefined.

Domestic R&D expenditure. Endogenous growth theories predict R&D activities to be an important determinant of TFP growth since innovations can ultimately raise efficiency [28-30]. The variable *rd* is included in our model to proxy the domestic firms' absorptive capacity. A certain level of absorptive capacity is required to absorb foreign technology [31]. Domestic R&D expenditures influence domestic TFP in three ways. Firstly, R&D may be cost reducing, lowering the production costs. Secondly, firms may create and produce new products with R&D expenditures by using the same volume of factors. Finally, R&D activities increase the capacity of domestic firms to imitate new technologies and use it as a proxy for absorptive capacity [32-34]. Thus, we expect a positive sign for the coefficient of *rd*.

Average sectoral R&D expenditure of foreign firms. The variable *mrdf is* included in our model to proxy the average stock of foreign knowledge in each industry. Liu and Buck [31] found evidence that foreign R&D activities had positive impacts on the innovation performance of domestic firms if domestic firms possess the absorptive capacity to learn foreign knowledge. Because innovations are a source of TFP growth, we expect a positive sign for the coefficient of *mrdf*.

Scale. Small firms have less capacity to benefit from the foreign presence and are less capable to face competition [35]. Yet, some studies [36-38] find that only small domestic firms (and medium in the latter case) benefit from positive externalities from FDI. Hence, the evidence on the impact of scale on firms' productivity appears to be inconclusive. Nonetheless, in the presence of increasing returns to scale, i.e., if there is an industry-specific optimal scale, then TFP increases with scale [39-40] and we expect a positive coefficient for *s*.

Technological gap. The determinants of technology diffusion build on models by [30, 41-43]. Following Gerschenkron [44] hypothesis, technological progress is an increasing function of the technology gap (*tg*). We define a way to measure the speed of technology diffusion, i.e., to capture autonomous technological transfer from foreign firms to technologically laggard domestic firms [45-46]. The indicator is a ratio of labor productivity between domestic firms and the presumptive foreign leader. Therefore, the variable *tg* is constructed as an inverse measure of the technological gap since values of this variable close to 1 mean a small gap, and values close to 0 signify a large gap. Thus, and according to the catching-up hypothesis, if the value of *tg* is close to one, the gap is too small, which means that domestic and foreign firms possess similar levels of efficiency and, thus, the domestic firms are not prone to learn much from the MNCs. However, according to the technology-accumulation hypothesis, if the value of *tg* is close to zero, the gap is too large; which means that domestic firms do not possess the necessary "absorptive capacity" to incorporate the knowledge of foreign firms [32, 47-49]. Thus, the expected coefficient of this variable is not predefined.

***Capital intensity*.** Capital intensity represents a firm's commitment to modernization and upgrading of its productive capacity. In the long run, capital expenditures typically have a positive impact on firms' performance [50-51]. The higher the capital intensity is, the higher the expected TFP [52]. Hence, we expect a positive coefficient for *kl*.

Interaction variables. These variables are included in our model to test the impact of foreign presence on the TFP growth of Portuguese manufacturing firms, given the values of concentration, absorptive capacity, and a sectoral average of foreign knowledge, scale, and technological gap, and capital intensity. Thus, we include the interaction variables labeled *F*hfd, F*rd, F*mrdf, F*s, F*tg,* and *F*kl*, respectively. Where *F* stands for the measure of foreign presence in the same industry (*hor)*, in downstream (*back)* or upstream industries *(for).*

FDI and concentration. If the impact of the variable *F*hfd* is positive, it means that the impact of foreign presence in the TFP growth of Portuguese manufacturing firms is positive, given the values of market concentration. In other words, the influence of concentration on the referred impact is positive because the benefits of having market power outweigh the potential disadvantage of inefficiencies from monopoly rents; and otherwise, if the value of *F*hfd* is negative. Hence, the sign of *F*hfd* is not predefined.

***FDI and absorptive capacity*.** From what was said above about the domestic firms' absorptive capacity, we assume that the impact of foreign presence in the TFP growth of Portuguese manufacturing firms, given a certain level of absorptive capacity, is positive, i.e., that the coefficient of the variable *F*rd* is positive.

FDI and the average stock of foreign knowledge in the industry. The empirical literature provides evidence of the positive impacts of foreign R&D activities on the innovation performance of domestic firms, as described above. Hence, we assume a positive impact of foreign presence in the TFP growth of Portuguese manufacturing firms, given a certain level of foreign R&D activities. The expected sign for the variable *F*mrdf* is positive.

FDI and scale. We assume a positive impact of foreign presence in the TFP growth of the Portuguese manufacturing firms, given a certain level of scale, because the adoption of an efficient scale of operations is important to increase the TFP. Consequently, we expect a positive sign for the variable *F*s*.

***FDI and technological gap*.** For the Portuguese economy, Flôres et al. [53] suggest that the externality effects are maximized when the technological gap is between 50%- 80% while Proença et al. [12] find that *tg* must be around 60%-95% to maximize the externalities. Thus, the expected sign of *F*tg* is not predefined.

***FDI and capital intensity*.** Foreign firms usually use more capital-intensive technologies [54-55]. The extent to which local firms benefit from this superior technology depends largely on their own technological capabilities as defined by capital intensity [56-57]. Therefore, we assume a positive impact of foreign presence in the TFP growth of Portuguese manufacturing firms, given a certain level of capital intensity, and expect a positive sign of *F*kl*.

Thus, in the second stage of our econometric strategy, the growth of the estimated TFP is regressed against a set of variables that measure the foreign presence, interaction terms, and other explanatory variables, within a fixed-effects dynamic model**,** including a time trend. The econometric specification is

$$d\hat{tfp}_{ijt} = \beta_0 + \beta_1 \hat{tfp}_{ij(t-1)} + \beta_2 \sum_{m=0}^{2} f_{j(t-m)} + \beta_3 (f_{jt} * hfd_{ijt}) + \beta_4 (f_{jt} * rd_{ijt}) + \beta_5 (f_{jt} * mrdf_{jt}) + \beta_6 (f_{jt} * s_{ijt}) + \beta_7 (f_{jt} * kl_{ijt}) + \beta_8 (f_{jt} * tg_{ijt}) + \beta_9 hfd_{ijt} + \beta_{10} rd_{ijt} + \beta_{11} mrdf_{jt} + \beta_{12} ds_{ijt} + \beta_{13} tg_{ijt} + \beta_{14} kl_{ijt} + \gamma_t + \mu_{it} \quad (12)$$

Where the lowercases denote variables in logarithms and f is the measure of foreign presence (*hor, b1,* and *f1*). we also include year dummies γ_t that account for possible changes in the growth of TFP due to stochastic shocks at a firm or sectoral level over time and an error term μ_it. If it is expected that the current level of the dependent variable (DV) is heavily determined by its past level, then we use a dynamic specification that includes a lagged dependent variable ($\hat{tfp}_{ijt-1}$). The inclusion of lagged DVs is necessary to avoid unreliable results due to an omitted variable bias and reduce the occurrence of autocorrelation arising from model misspecification. we include two lags of the variables that represent the foreign presence since empirical studies indicate a period of two years for domestic firms to absorb the foreign knowledge and externalities to materialize. For example, Merlevede et al. [58] find evidence that "the first two years after entry, domestic firms that supply minority foreign entrants enjoy a substantial contribution to productivity growth" (*op cit.* p.22). we use the Sys-GMM to estimate equation (12), which combines the equation in first differences with the equation in levels. Hence, we use fixed effects in the equation in levels. In this dynamic model, the lagged dependent variable ($\hat{tfp}_{ijt-1}$) may be correlated with the error term (μ_it) and the endogenous variables, causing the OLS estimator to be inconsistent and biased [59]. Nickell [60] demonstrated that the use of the within estimator (also known as fixed effects estimator) in first-order autoregressive models with fixed effects leads to biased results for the estimated coefficient of the lagged dependent variable. However, there is still the autocorrelation problem since the term $\hat{tfp}_{ijt-1}$ is correlated with the term $\mu\_(i,t-1)$ in$d\mu_it = \mu_(i,t) - \mu_(i,t-1)$. The independent variables are endogenous (*kl, tg, f, f*hfd*); predetermined (*s*) and exogenous (*hfd, rd, mrdf, f*mrdf, f*s and f*tg)*. However, any not strictly exogenous predetermined variable becomes potentially endogenous since it can also be correlated with the error term $\mu\_(i,t-1)$ [61]. Arellano and Bond [52] and Bond [53] suggest the use of instrumental variables in equation (12) to deal with the autocorrelation and endogeneity issues. Considering equation (12), we use lags of the dependent variable in levels, lagged two or more periods, as valid instruments for periods t=3…, T, as in Arellano and Bond [62] and Bond [63].

Since the variables that proxy for foreign presence are highly correlated, we regress each type of externality for domestic firms in a separate equation. we use the command *xtabond2* in software STATA 13.0 to implement the System GMM two-step estimator with the Windmeijer (2005) correction. Industries of tobacco and petroleum (with codes 12 and 19 according to classification Nace Revision 2) were dropped due to an insufficient number of observations.

5 Results

Table 2 (in annex) presents the impact of company size on externalities, by type of externality and technological groups. Examining Table 2, we can conclude that the large size influences the occurrence of externalities in scale-intensive industries. There are significant and positive horizontal externalities in food industry, and backward and forward linkages in beverages industry. However, FDI only has an effect in terms of externalities with time lags except for backward linkages in beverages, where externalities are an immediate effect of foreign presence. The large size is also important for externalities to occur by backward linkages in the repair installation of machinery and equipment immediately.

With respect to small firms, we find positive horizontal externalities in scale intensive industries such as basic metals and other transport equipment; and in specialized suppliers (repair and equipment) and science-based industries (computers and electronics). Except for basic metals where the externalities occur immediately, in the remaining industries, it takes one or two periods for horizontal externalities to occur.

we find externalities via backward linkages in scale-intensive industries like basic metals and other transport equipment, but with a lag; we also find positive externalities with lags in science-based industries (computers and electronics).

We find positive externalities through forward linkages in scale-intensive industries such as beverages and metal products; and also in science-based industries (electrical equipment). Except for beverages, externalities via forward linkages occur with lags.

6 Discussion

The validity of the results with system-GMM depends on the statistical diagnostics. we started by testing for the presence of second-order autocorrelation in the error term. The presence of AR (1) poses no problem because the differenced residuals are expected to follow a MA(1) process, however, if there is AR(2) autocorrelation, then the GMM-estimator is inconsistent. The reason is that the Arellano-Bond (AB) orthogonality conditions are established under the assumption that the error term in the level's equation is not auto correlated. If the error term in the level's equation is not autocorrelated, then the error term in the first-difference equation has negative first-order autocorrelation and 0 second-order autocorrelation. If one rejects the hypothesis that there is 0 second-order autocorrelation in the residuals of the first-difference equation, then one also rejects the hypothesis that the error term in the level's equation is not autocorrelated.

This indicates that the AB orthogonality conditions are not valid, no matter which lags are used as instruments. Thus, we tested for second-order serial correlation. we also report the results of Hansen's J test of overidentifying restrictions but not the Sargan's statistic. The reason is that Sargan's statistic is a special case of Hansen's J under the assumption of homoscedasticity.

Table 2. Impact of firm size on FDI externalities

		Scale			**Specialized Suppliers**	**Science-Based**	**Supplier-Dominated**
	Industry	Food	Basic Metals	Other Transport Equipment	Repair and Installation of Machinery & Equipment	Computers & Electronics	
Horizontal	Signal	+	+/-	+	+	+	
	Period	-1, -2	0,-1	-1, -2	-2	-1, -2	
	Size	Large	Small	Small	Small	Small	
	Industry	Beverages	Basic Metals	Other Transport Industries	Repair and Installation of Machinery & Equipment	Computers & Electronics	Wood
Backward	Signal	+	+/-	+	+	+	-
	Period	0	-1, -2	-1, -2	0	-2	0
	Size	Large	Small	Small	Large	Small	Large
	Industry	Beverages	Metallic Products			Electrical Equipment	Wood
Forward	Signal	+	+/-			-/+	-
	Period	0,-2	-1, -2			-1, -2	0

Size	Small, Large	Small			Small	Large

A reasonable approach is to use robust standard error estimation to deal with heteroskedasticity (and thus rendering the Sargan test unjustified), and then test for the remaining autocorrelation using the autocorrelation test which is more sensitive to such problems than the Sargan test. Following Roodman [61], we also report the number of instruments used in the dynamic panel, since this kind of models can generate an enormous number of potentially “weak” instruments that can cause biased estimates. There are no clear rules concerning how many instruments is “too many” [61], but the number of instruments should not exceed the number of groups, which is the case. Second, the p-value should have a higher value than the conventional 0.05 or 0.10 levels. we examined the sensitivity of system-GMM regression results to the number of lagged instruments and to alternative number of independent variables.

However, in theses alternative specifications, Arellano-Bond [AR (2)] and Hansen tests rejected the null hypothesis and/or the coefficient of variables become non-significant. Tables 3 to 20 show that the results for AR (2) and Hansen's J test support the validity of the chosen model specification. In this analysis, we report only the significant results (p-values are listed in parenthesis, next to the coefficient values). The Impact of Size in Scale-Intensive Industries-

Although this research shed light on FDI externalities, it is not exempt of limitations. First, it was necessary to obtain disaggregated data at the firm level from different sources, that had to be harmonized. Secondly, data referring to human capital and R&D are lacking, so we had to use proxies with their inherent limitations. Thirdly, we do not have input-output tables for all years and had to assume that values would not change largely each year.

7 Conclusıon

The Portuguese manufacturing industry is characterized by small companies and a dynamic of innovation that relies heavily on the so-called traditional industries. These industries are characterized by small firms, typically producing low value-added products, which potentially threatens the growth of TFP. With this in mind, we investigated whether firm size is more likely to benefit from FDI externalities in 1995-2007. Grouping industries by technological groups, we find that FDI externalities in the analyzed period are more likely to occur via horizontal or backward links, in small scale-intensive companies with time lags. However, there are also positive externalities via forward linkages in scale-intensive, science-based and supplier-dominated industries.

Negative externalities occur only in basic metals, metallic products, electrical equipment and wood products.

Summing-up the externalities by size, we find that 1% increase in the turnover of foreign firms increases the TFP of small domestic firms in nearly 0.71 percentage points and of large firms in nearly 0.45 percentage points. Performing the same exercise by period, we conclude that the magnitude of increases in the TFP of domestic firms is higher in lagged periods (0.44 p.p. after 2 year and 0.37 after 1 year of the arrival of the foreign firm), although the magnitudes are very similar, as well as the one in the current period (0.34 p.p.). Thus, we confirm that externalities take time to occur, possibly because domestic firms need time to absorb the foreign knowledge.

Accordingly, the Portuguese Investment Promotion Agency (AICEP) should endeavor to stimulate FDI in scale intensive and science-based industries. This could be achieved, in the case of horizontal externalities, by providing incentives for R&D cooperation and supporting private sector training programs. On the other hand, the government can contribute to the occurrence of vertical externalities from FDI by supporting partnerships with foreign firms. This can be attained by several ways: providing linkage information in seminars, exhibitions, and missions; sponsoring fairs and conferences; organizing meetings and visits to plants; promoting supplier associations; and providing advice on subcontracting deals. These results, compared with previous econometric studies analyzing the consequences of FDI in Portugal, show that FDI has a wider range of consequences than previously assumed. It has been shown in this study that industries are affected by FDI in different ways. None of the previous studies has analyses all the consequences investigated in this study. First, this study is based on more recent and previously unexplored datasets, and we use a large panel of manufacturing firms which allows us to control for firm fixed effects and year effects, ruling out main concerns related to endogeneity. Second, we are one of the few authors that investigate the existence of both horizontal and vertical externalities from FDI in Portugal. Third, we use lags of the measures of foreign presence to account for the time lapse required for externalities to materialize. Fourth, we break down the results across industries along their trajectories of technological change which allow us to uncover some interesting patterns. Indeed, the technological groups more positively affected by foreign presence are scale intensive and science-based industries. Thus, an important contribution has been made by providing a more complete picture of the effects of FDI in Portugal. By and large, the fact that externalities from FDI are unevenly distributed across firm sizes and may take up to 2 years to occur, makes possible to understand the conflicting results of previous studies for Portugal. This analysis provides enough incentive for further research. Avenues of future research include extending the research for recent years.

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