Foreign Direct Investment and Technology Spillovers: Which Firms Really Benefit?

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Contents: I. Introduction.- II. Theoretical framework.- III. Model, data and variables.- IV. Empirical findings.- V. Concluding remarks.

Abstract: Foreign direct investment is thought to contribute to host economies by increasing their efficiency either directly or through technology diffusion. Such efficiency benefits are neither equally produced by foreign firms nor equally distributed to all domestic firms. The special question addressed in this study is related to how differentiated such effects are depending on size and degree of (foreign) ownership. Based on a sample of 3,742 manufacturing firms operating in Greece in 1997, it is found that, while it is large, majority-held foreign firms that exhibit higher productivity, spillovers are important for small domestic firms and stem mostly from small joint ventures where the foreign partner owns a minor part of equity. Policy recommendations follow. JEL no: F23; O30.

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I. Introduction

The impact of Foreign Direct Investment (FDI) on host economies remains one of the most important questions in the international economics literature, faced with renewed interest in recent years. Two main issues dominate the discussion: (a) the efficiency benefits that come along with FDI and may lead to direct increases in local productivity and to indirect improvements in domestic performance through spillovers, and (b) the costs incurred by domestic firms due to the entry of more efficient rivals in the market, which may lead to a reduction in produced output, pushing domestic firms up their average cost curves, thus decreasing productivity. Local conditions, such as the openness of the economy, the institutional framework, the technology gap, the degree of competition, and the skill level of the workforce may also influence the relative size of costs and benefits.

Numerous studies have attempted to provide theoretical and empirical answers to the question of the overall impact of FDI on the host economy as determined by such countervailing effects. Theoretical analyses have provided interesting and testable propositions valid under certain conditions and pointing towards a positive overall FDI effect.[1] Empirical studies performed at the level of the firm have measured the importance of efficiency benefits enjoyed by foreign firms as well as the extent of spillovers in host markets stemming from foreign presence, resulting in mixed results varying from positive to insignificant or even negative estimates.[2] In an attempt to resolve such ambiguities Görg and Strobl (2001) have performed an interesting meta-analysis of the estimated productivity spillovers of FDI as published in earlier empirical studies. These ambiguities are attributed mostly to differences in the research design, the methodology and the type of data (cross-sectional versus panel

[1] See, for example, Wang and Blomström (1992), Markusen and Venables (1999).

[2] See, for example, Oulton (1998), Aitken and Harrison (1999), Blomström and Sjöholm (1999), Chhibber and Majumdar (1999), Sjöholm (1999a; b), Girma et al.(2001), Kokko et.al. (2001), Conyon et. al. (2002), Griffith (2002) and Dimelis and Louri (2002).

data). On the other hand, studies conducted at the industry level have revealed positive industry responses under certain industry structures.[3]

At a more aggregate level it has been found that innovating sectors invest more abroad. Subsequently, FDI is thought to bring along new technologies, which may then be diffused to domestic firms. Following this line of thought it has been suggested that 30% of the growth in UK manufacturing productivity in 1985-94 can be attributed to the presence of FDI.[4] Although attempts to measure the aggregate consequences of FDI have supplied rather ambiguous results, most of the relevant literature favours a positive, while not generalized effect.

Nevertheless, the great majority of empirical studies on FDI spillovers refer to cases where the host country is a developing one, the market characteristics of which are quite different from the characteristics of a developed economy.[5] Hence the need for further studies seeking to provide answers on particular aspects and conditions of the FDI impact on other economies as also argued by Blomström et al. (2001) in their review paper.

Our study attempts to analyze the net efficiency benefits stemming from FDI in the particular case of Greece, a small open and developed economy as well as a peripheral country of the EU with an emphasis on the distiction between spillovers from different types of multinationals. More specifically, the questions addressed are related to how differentiated such effects are depending on the size of domestic and foreign firms as well as on the degree of involvement of the foreign partner. Is the presence of small and large foreign firms equally beneficial for the local economy? Are small and large domestic and foreign firms benefiting the same from the presence of multinational corporations (MNCs) in their industries, irrespective of the degree of their involvement in ownership? And if the benefits are different, what are the implications for the particular host economy and policy guidelines towards FDI? The answers to the above questions can be useful to future EU host countries, which are interested in knowing what to expect from the establishment of foreign affiliates or how differentiated the expected benefits may be. The paper is organised as follows. Section II explains the theoretical base for the role of foreign ownership in firm

[3] See, for example, Blomström (1986), Davies and Lyons (1991), Kokko (1994), Driffield (2001).
[4] See Barrell and Pain (1997).
[5] As shown by Görg and Strobl (2001), among the nineteen published papers they could trace on productivity spillovers of FDI, only five refer to developed countries, of which three are on the UK and the other two on Australia and Canada.

efficiency and technology spillovers. Section III presents the econometric model, the data and the variables used in the estimations. Section IV presents the empirical results and considers some further econometric issues and section V concludes.

II. Theoretical framework

MNCs possess knowledge-based, firm specific assets that give rise to cost advantages at the (parent) firm level. Such advantages create multi-plant economies of scale which combined with a reduction in transport and/or trade costs when locating close to national markets explain the creation of subsidiaries there (Markusen 1995). Licensing incurs the double risk of not keeping the quality standards of the parent company and appropriating technology-based secrets. Thus, ownership of local subsidiaries may be preferred (Cleeve 1997).

There is a large literature on the reasons for which one expects the presence of MNCs to impact positively on the host economy. First, foreign subsidiaries are expected to be more productive than domestic firms, other things being equal, due to higher technology inputs and more efficient organization in production and distribution. They tend to operate on a lower (production and distribution) cost curve than domestic firms, hence their ability to compete successfully although their knowledge of local markets and consumer preferences may be inferior. Their higher productive efficiency helps productivity in their industries to shift upwards which is also mirrored in the general productivity of the host economy (Caves 1996).

Second, there are spillovers, which affect the productivity of domestic firms and provide the longer lasting gains for the host economy. The public good nature of the knowledge-based assets transferred to the host country is a main source of spillovers. Appropriation of their qualities may take place through reverse engineering, employment turnover or direct contact with local agents. Local suppliers and sub-contractors may benefit from new technology information disseminated by MNCs in order to satisfy their advanced technical standards. Such technology diffusion improves the technical efficiency of domestic firms (Blomström and Kokko 1998). Foreign firms may also benefit from enhanced foreign presence in their host industries if, for example, the supply of skilled labour is consequently increased or information about local market conditions is facilitated.

Strengthening competition, since MNCs usually enter markets with high entry barriers and consequently strong oligopolistic rigidities, may also be important. Domestic firms, not challenged before by local contenders, are forced to become more efficient in order to keep their market shares. Allocative efficiency in the industry is thus improved. Driffield (2001) argues that the most likely benefit from FDI in the UK is the stimulation of domestic productivity through increased foreign competition.

A negative effect may be expected if market stealing on behalf of MNCs takes place. In this case, although firms benefit from spillovers and move to a lower average cost curve, the cost per unit produced is higher since output demanded from them is reduced because foreign firms take over a large part of the market (Haddad and Harrison 1993; Aitken and Harrison 1999).

Efficiency enhancing or reducing effects are not evenly spread among industries or countries. Their magnitude and scope depend on the development stage of the economy, particular characteristics of the host markets, the structure of industries, institutional factors, trade regimes as well as attributes of the local workforce. Cantwell (1989) notices that the benefits of foreign (US) presence seem to be more obvious in European industries possessing some technological strength. On the contrary, firms in technologically weaker or smaller markets (led to operate at an inefficient scale) are often forced to closure. Wang and Blomström (1992) develop a formal model, which explores special domestic conditions that facilitate technology transfer. On the negative side are perceived operation risks, while learning efforts of domestic firms facilitate the process. Kokko (1994) estimates that spillovers are smaller in Mexican industries with 'enclave' characteristics, i.e. industries where MNCs operate in isolation from local firms because of high technology gaps and large foreign concentration. Blomström and Sjöholm (1999) estimate that spillovers are not significant in Indonesian sectors open to foreign competition, since such sectors are already operating at the top of their efficiency. On the other hand, Sjöholm (1999a) finds that spillovers are stronger in Indonesian sectors where domestic competition is higher and technology less advanced. A larger technology gap seems to leave more ground for improvements. In another study, Sjöholm (1999b) argues that regional spillovers may be stronger than national spillovers due to exploitation of local linkages. Blomström and Kokko (1998) maintain that the higher the level of local competence and the more competitive the market environment, the higher is the absorptive capacity of and the positive benefits for the host country. Girma,

Greenaway and Wakelin (2001) confirm that the impact of FDI in the UK increases the higher the levels of import competition and skills in an industry. In a similar analytical framework Kokko et. al. (2001) report FDI spillovers as depending on trade regimes as well as the export orientation of the recipient firms. Finally, Dimelis and Louri (2002) provide evidence for differentiated spillover effects at various quantiles of the conditional distribution of domestic productivity in Greek manufacturing industry.

Spillovers may be limited if foreign subsidiaries are fully or majority owned because interaction with local agents is reduced. Interaction is easier with minority foreign ownership because local partners have direct access to information. Subsequently, leakage of important information-based assets to initial partners and future competitors may be significant particularly in R&D intensive industries (Nakamura and Xie 1998; Barbosa and Louri 2002). For this reason, a foreign partner has an incentive to increase his ownership share in order to protect his property rights and to control the use of his intangible assets. Thus, property rights acquired with (the degree of) ownership are important in determining the overall impact of FDI. Size may also be thought as playing a dual role. Large foreign firms may be better prepared to face their needs on their own, thus operating in isolation from the local environment. On the other hand, small foreign firms may be more willing to buy from or subcontract to local firms engaging in more intensive interaction, resulting in higher spillovers.

Furthermore, domestic firm size may be important in absorbing spillovers. Large domestic firms may already be competitive and operating at their maximum efficiency, especially if they also happen to be large exporters. In this case, their performance is disciplined by international competition and apparently there may be little technical knowledge to be transferred to them from MNCs. Nevertheless, small domestic firms may not be exposed to foreign pressure and may operate at sub-optimal efficiency, lacking technical know-how that interaction with locally established MNCs may offer them. Hence, they are likely to be more seriously influenced by foreign presence in their industries, and enjoy higher spillover benefits.[6]

[6] Aitken and Harrison (1999) is, to our knowledge, the only paper that has attempted to measure differences in FDI spillovers on productivity by plant size and estimated negative effects for small Venezuelan firms attributed to market stealing on behalf of MNCs.

In the great majority of the existing empirical literature, the effect of foreign ownership on the performance of host firms, industries or countries is measured by a dummy variable indicating the foreign presence, while the spillover effect by defining the foreign share in employment/sales or other equivalent measure depending on data availability. The disadvantage of employing a dummy to measure the FDI impact is that it only implies shifts in productivity, leaving out any slope effects which may possibly arise. To this end, some studies have exploited the availability of more detailed information to estimate if the foreign impact on performance increases monotonically with the degree of foreign ownership (Aitken and Harrison 1999). Fewer studies suggest that foreign ownership may have a significant impact on firm performance only when it crosses a certain threshold providing unambiguous control and being defined by the property rights regime (Chhibber and Majumdar 1999; Blomström and Sjöholm 1999). If full firm efficiency is to be enjoyed, foreign owners should be permitted full control over firms.

However, changes in productivity may arise not only as a result of the foreign presence, but also because FDI may be directed to firms or industries of particular characteristics (e.g. larger in size or more capital intensive). The omission of such characteristics from our analysis will most likely create a selection bias problem. This implies that productivity models should allow for differentiated effects arising not only from the actual FDI variable but also from industry and firm specific characteristics. It is along these lines that this study attempts to estimate the direct and indirect effect that MNCs exercise on labour efficiency.

III. Model, data and variables

The econometric model adopted for the purpose of this paper, the data used and their statistical properties as well as the definition of variables have as follows:

The model

Starting with a general form of production function, output of the ith firm is assumed to be determined by

$$\begin{aligned} Y_i &= F(K_i, L_i)\, e^{Z_i} = F(K_i, L_i)\, e^{\hat{Z}_i + e_i} \\ &= F(K_i, L_i)\, e^{\Sigma \gamma_j X_{ij} + e_i} \end{aligned} \qquad (1)$$

where K_i and L_i denote the capital and labour inputs respectively of firm i and Z_i is assumed to measure exogenous shocks to production which are partially observable ($\hat{Z}_i$) and partially random (e_i). For empirical purposes, a simple Cobb-Douglas form[7] is specified for the production function F, while $\hat{Z}_i$ is proxied by a number of exogenous to production variables X_{ij} the impact of which is denoted by γ_j, that is $\hat{Z}_i = \Sigma\ \gamma_j\ X_{ij}$. Subsequently, considering the above specifications and taking logarithms, we obtain the following econometric equation

$$lnY_i = \gamma_0 + \alpha\ lnK_i + \beta\ lnL_i + \Sigma\ \gamma_j X_{ij} + e_i \qquad (2)$$

where α and β are the elasticities of output with respect to capital and labour respectively; γ_0 is a constant parameter corresponding to $X_0=1$, but can be allowed to vary by specifying industry-specific or other dummy variables among the X_j's reflecting, for example, variations in technology levels, management skills, etc. Additional X_j variables that account for observed heterogeneity among firms or capture possible externalities will also be considered as explained in more details below. Finally, the error term e_i absorbs all stochastic variations in the technological capabilities of firms, missing variables or various measurement errors.

Since our main issues relate to productivity, we rearrange (2) so as to obtain its labour intensive form

$$ln(Y_i/L_i) = \gamma_0 + \alpha\ ln(K_i/L_i) + (\alpha+\beta-1)lnL_i + \sum \gamma_j X_{ij} + e_i, \quad i=1, \ldots,N \qquad (3)$$

where the term $(\alpha+\beta-1)$ measures deviations from constant returns, readily tested by the t-statistic of its estimate. Equation (3) is also more appropriate for estimation since several econometric problems such as heteroscedasticity due to the use of cross-sectional data, simultaneity due to the endogeneity of production inputs or multicollinearity arising from the interdependence of the two inputs are reduced.[8]

[7] More complex forms like CES or translog specifications could also be considered, although econometrically, quite often, the increased complexity resulting from such forms results in luck of robustness in the estimation process.

[8] For more details on the econometric aspects of production functions, see Intriligator et al. (1996, Chapter 8).

More specifically, for measuring the impact of foreign presence on productivity, a variable, FDI, is specified taking as values the percentage of ownership in equity the foreign partner holds in each particular firm. These values therefore will range from 0 if the firm is domestic to 100% if the firm is entirely foreign-owned. According to the theory, different degrees of foreign ownership may cause different shifts at the level of productivity. To test this assertion, two separate dummy variables, *Min* and *Maj* taking the value of 1 if the share of the foreign firm is ≤ 50% or >50% respectively may replace *FDI*.[9] A variable measuring the spillover effect from the presence of foreign owned firms is also included among the regressors. [10]

Furthermore, firms may differ in productivity for other reasons, some of which have been documented in the literature such as the scale of the firm, the skill level of labour, and financial constraints. Given the data availability in our sample, the additional variables X_j considered include a measure of the firm's scale and two financial variables, namely the leverage of the firm defined as the ratio of short and long-term debt to net worth and the liquidity ratio defined as working capital over total assets. [11] Scale is expected to increase productivity, if firms benefit from scale economies (Baldwin 1996). The financial variables of leverage and liquidity may reflect either the consequences of financial pressure (Nickell et. al. 1992; Nickell and Nicolitsas 1999) or the ability of the firm to exploit investment opportunities (Caballero 1997; Hubbard 1998) both expected to increase efficiency. Product market characteristics, taken into account by an industry dummy, may also be of importance in determining productivity.

A preliminary investigation of the data indicated the existence of statistically significant differences in productivity between small (≤50 employees) and large firms (>50 employees) in particular among the foreign ones.[12] It is important therefore to

[9] Full ownership and the parity option may also be tested as separate foreign ownership categories. In our case they did not produce any statistically significant different results from the two options presented. Hence they were integrated in the *Maj* and the *Min* ownership variables respectively.

[10] Details on the measurement of the spillover effects are provided in the next sub-section.

[11] Two more variables, suggested by the literature as determining productivity, namely labour skills and firm age, were initially used in the econometric estimations. Since neither was found to be significant, they are not included in the X_js described here or in the estimations provided in section IV. Exports have also been suggested. Sectoral data on exports have been used in a working paper by Barrios et al.(2002) comparing small groups of firms in Greece, Ireland and Spain. No evidence was found of differences in productivity between export-intensive and non-intensive sectors, probably because all manufacturing sectors in Greece (a small open economy) are subject to strong competition from international trade.

[12] A Chow test was performed to test the hypothesis of lack of differences in the coefficients of the productivity regression equation between small and large firms. The hypothesis was rejected at p=0.00.

control for the size effects exerted on productivity, thus avoiding some sort of heterogeneity bias, which would otherwise be introduced in our estimates. Controlling for size can be implemented by either pooling small and large firms together and introducing the appropriate dummies for differentiated constant and/or slope effects, or splitting the sample accordingly and perform separate regression estimates. Since we are dealing with a large sample we follow the latter approach and estimate model (3) separately for each group. In this way we are also able to obtain directly the estimates of the FDI impact on productivity in each group after controlling for a variety of firm specific factors.

The data

The data source is in the published accounts of all Greek manufacturing corporations operating in 1997 as collected and compiled by the data bank of ICAP. The sample is by definition biased towards large-sized firms, which reportedly produce more than three quarters of manufacturing sales. Financial information together with data on foreign ownership, employment and age is provided. The number of firms used in our econometric estimations is reduced to 3742 (out of 4056) due to missing variables for some firms and the inclusion only of sectors with foreign presence (three sectors in the sample had no foreign presence). There are 207 fully or partially owned foreign firms, which despite their small number produce 26% of their industries' sales.

Table 1 gives a brief description of the sample finally used in terms of industry and size distribution. The relative presence of foreign firms is more intense (in terms of shares) in chemicals, oil refineries and electric machinery. Such sectors show higher productivity, so the higher presence of foreign firms there may show their preference to locate in sectors where productivity is already high. In terms of size, while only 26% of domestic firms are considered to be large (>50 employees), almost 3 times as many of the foreign firms (72%) are large. Hence, foreign firms show a noticeable preference for large size and certain high productivity industries. For this reason we control for such effects in the estimations in order to avoid causality problems and obtain an 'unmixed' FDI effect.

Table 2 provides some more information on the ownership preferences of foreign firms indicating that most (113) prefer majority (>50%) ownership. Almost 80% of them are large, as opposed to 62% of the minority held ones being large. In terms of labour productivity, foreign firms are 1.8 times more productive than domestic firms

but there are differences between majority and minority held foreign firms, the former being on average 16% more productive than the latter. The largest difference in productivity is noticed in the large group between majority held foreign firms and domestic firms, the former being 2.1 times more productive than the latter. Finally, in terms of total assets, large, majority owned foreign firms definitely exceed all other groups.

Variables

Output in this paper is measured by sales as reported by the 1997 directory of published company accounts.[13] The choice of independent variables is determined by the theoretical issues, the econometric model and data availability. They are defined as follows:

KL (capital labour ratio): Fixed capital over employment of firm *i* (in log form).

SCALE (within firms): Size of total assets of firm *i* (in log form).

DEBT (leverage ratio): Short and long term debt over net worth of firm *i* (in log form).

LIQ (liquidity ratio): Working capital over total assets of firm *i* (in log form).

FDI (foreign ownership share): Percentage of capital equity held by foreign investors in firm *i*.[14]

FMAJ (majority foreign ownership): Dummy variable equal to 1 if foreign investors own more than 50% of the equity of firm *i*.

FMIN (minority foreign ownership): Dummy variable equal to 1 if foreign investors own less than or equal to 50% of the equity of firm *i*.

FDISM (small foreign firms): Dummy variable equal to 1 if foreign firm has less than 50 employees.

FDILG (large foreign firms): Dummy variable equal to 1 if foreign firm has more than 50 employees.

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[13] Value added would be preferable in this context but it was not reported in these accounts, nor was it possible to obtain it from another source. Arguments for the use of sales when value added is not available can be found in Nickell et al. (1992), Mayes (1996) and Oulton (1998) among others.

[14] A dummy equal to 1 for foreign firms and 0 for domestic firms was also used, as is typical in the literature. Its effect was estimated as positive and significant. Still, the foreign ownership share is preferred as a variable taking into account more detailed information about the role of foreign presence and is adopted in the estimations reported.

FK (share of foreign capital): Fixed capital belonging to foreign firms in industry *j* over total fixed capital in the same industry. This variable measures the spillover effect and is computed at the three-digit industry level.[15]

FKMAJ (capital share of majority owned foreign firms): Fixed capital belonging to firms with majority foreign ownership in industry *j* over total fixed capital in the same industry.

FKMIN (capital share of minority owned foreign firms): Fixed capital belonging to firms with minority foreign ownership in industry *j* over total fixed capital in industry *j*.

FKSM (capital share of small foreign firms): Fixed capital belonging to foreign firms with less than or equal to 50 employees in industry *j* over total fixed capital in industry *j*.

FKLG (capital share of large foreign firms): Fixed capital belonging to foreign firms with less than 50 employees in industry *j* over total fixed capital in industry *j*.

Industry dummies: Twenty two-digit industry dummies are used.

IV. Empirical findings

As a first step, equation (3) was estimated using all firms and the relevant independent variables to check for constant returns to scale. Since the coefficient of the variable lnL_i was not statistically significant different from zero, it was concluded that the hypothesis of constant returns cannot be rejected and hence, all subsequent regressions were run without this variable. The OLS estimation results are reported below, while further considerations on the results are provided in subsequent section.

Estimation results

Tables 3-6 present the White heteroscedasticity corrected productivity estimations (p-values in parentheses), taking into account different samples and different ways in which FDI spillovers may appear. Industry dummies at the two-digit level are included in the reported estimations to control for productivity differences across

[15] The spillover variable is most often measured in the literature as a ratio of the output (e.g. Blomström and Sjöholm, 1999) or employment (e.g. Aitken and Harrison, 1999; Girma, Greenaway and Wakelin, 2001) of foreign firms with respect to the output or employment of their industries. Since the commitment of foreign firms in terms of fixed capital may be a better indicator of the technology they bring along and possibly transfer to local firms, we decided to adopt the fixed capital version as more relevant theoretically. Nevertheless, all three alternatives were tried and provided close results.

industries. Our estimations in each table come in three groups, all firms, small firms and large firms.[16]

The effects of scale, leverage and liquidity are positive and significant in all estimations. Scale exerts a positive effect on productivity as expected and the two financial variables are found to cause more efficient firm production. Although these variables perform well and improve significantly the explanatory ability of the model, our focus of interest is the changing role of foreign presence on productivity depending on firm size, degree of foreign ownership, and foreign penetration in each industry, and it is to these estimated effects that we now turn.[17]

Table 3 shows that when the sample of all firms is used a significantly positive effect of FDI on productivity is estimated increasing with the share of foreign ownership. Actually, a literal interpretation of the estimation of FDI impact in column 1 would mean that if foreign ownership in a firm increases by 10%, productivity is expected to increase by 2.3%. But as seen in column (2) when property rights arguments are taken into account (devolving full control to the foreign partner only when his capital holdings exceed 50%), such a positive ownership effect is found to exist only for majority-owned foreign firms. Firms with minority foreign holdings possess no productivity advantage over their domestic counterparts.

When the sample of small firms is used, no significant shift in productivity is estimated to be exerted either by the increasing ownership share or by the majority or minority foreign holding dummies. In the group of small firms, it does not matter if firms are domestic or foreign and if they have majority or minority foreign interests. No significant differences in productivity are estimated. Ownership does not affect productivity when firms are small.

On the contrary, when the sample of large firms is used (column 5) the effect of foreign share on firm productivity is found to be positive and larger than in any other estimation. It is further specified that such an effect stems only from majority owned foreign holdings. Thus, the conclusion can be drawn from Table 3 that the positive shift estimated to be exerted by foreign firms on productivity holds only for large

[16] Another approach would be to discard the observations in the middle of the size distribution and run our regressions using the upper and lower third of the distribution. The results obtained following this methodology were very similar to the ones reported.

[17] A Chi-squared test was performed and the hypothesis of excluding these extra variables from the model was rejected at p=0.00 ($X^2 = 1783.8$).

firms and comes mainly from firms where the foreign partner owns at least 51% of the firm equity.

Table 4 reports the efficiency shifts enjoyed by foreign firms and the spillover effects caused by foreign firms and enjoyed by all firms in our sample (domestic and foreign). As seen in column (1) both the foreign ownership share and the relative presence of foreign firms in each industry (measuring spillovers in terms of fixed capital) exercise a significantly positive effect on productivity of all firms. When estimated separately, though, it becomes obvious that spillovers are significant only in sectors where foreign firms have minority holdings. Spillovers are stronger in these cases, as argued in section 2, because appropriation and dissemination of technological information to domestic partners is easier.

According to the estimates presented in column 4, when all firms are taken into account and more detailed information is used, the positive productivity shift is found to be caused only by firms with majority foreign holdings, while the spillovers become significant in sectors where foreign firms have minority holdings. When the estimations are performed for the small (columns 5-8) and large (columns 9-12) firm groups separately, it is clearly shown that in the small firm group, the only significant effect exercised by foreign firms is the spillover effect. Spillovers stemming from firms with minority foreign holdings reach their largest size in this case. On the contrary, in the large firm group, the only significant effect of foreign presence on productivity is found to be the positive shift caused by firms in which the foreign partner owns more than 51% of the equity (columns 11 and 12).

Table 5 presents the estimates of the spillover effects on domestic firms only. In all cases they are smaller than when foreign firms are included (as in table 4) indicating that domestic firms benefit less from technology diffusion, information dissemination or even increased competition stemming from FDI than foreign firms in their industries. Still, positive spillovers are estimated only in the small firm group. It seems that large domestic firms do not seem to be influenced by the presence of foreign firms in their sectors, while small firms enjoy positive externalities. When tested further, such positive externalities stem mainly from firms with minority foreign holdings. The lack of significant spillovers for the large firm group may provide some explanation for similar results of other studies, if their sample includes mainly large firms, as for example in Girma et al. (2001).

Table 6 shows how differentiated the efficiency benefits are depending on the foreign firm size. Large foreign firms exercise a positive and significant shift on productivity, while the effect of small foreign firms is not significant. The spillover effects, though, are of a similar size and significance indicating that the presence of both small and large foreign firms in an industry exercises a positive influence on productivity, larger (although not significantly so) in the case of small firms.[18] The spillover effects of small and large foreign firms on all domestic firms are of slightly smaller size and significance, while such effects are found to be enjoyed only by small firms. The largest spillover effect among all estimations (in all tables) is estimated for small domestic firms indicating that a 1% increase in the capital share of foreign firms in their industry would increase the productivity of small domestic firms by almost 2% (column 6).[19] On the contrary, large firms (domestic or foreign) are not influenced by spillovers as was also the case in table 5.

Contrasting previous evidence, our results of the impact of foreign participation on the host country's efficiency are robust independent of whether or not we control for industry differences.[20] Furthermore, our results are in accordance with the general finding of a positive FDI shift on productivity, which, in the Greek case, is robust only for large domestic or foreign firms as opposed to the results of Aitken and Harrison (1999), who found it to be true only for small Venezuelan firms. Apparently, the institutional framework and the development stage as well as the degree of openness of the host economy play a significant part in the way the presence of MNCs affects local firms. Finally, given the existing ambiguity with respect to the net spillover effect of FDI, we estimate that it is in general positive, but is significant only for small domestic and foreign firms especially when stemming from small joint ventures.

Further econometric issues

When estimating production functions within a static framework as in the previous section, the well-known problems of multicollinearity and endogeneity may arise. As argued in section 3.1, these problems are alleviated by using the labor intensive form

[18] A Wald test was performed to test for the hypothesis of equal spillover coefficients from small and large foreign firms. The hypothesis was accepted at p=0.62.
[19] Despite the relatively large difference in the estimated coefficients a Wald test could not reject the hypothesis of equal coefficients at p=0.32.
[20] All regressions were re-estimated without the industry dummies. The results remained unchanged.

of equation (3), nevertheless the obtained estimates may lack some of the required properties, in particular unbiasedness and consistency. These problems are faced adequately by the use of instrumental variable (IV) techniques when a time dimension of the cross-sectional data is provided and, of course, in the case of panel data.[21]

In an attempt to increase the robustness of our results and given the limitation of our data set, we were able to trace back those firms from our sample that were operating in 1992. Thus, using the 1992 values of the exogenous variables as instruments, we re-estimated our regressions applying the IV procedure on the sample of firms operating in both years and the results are shown in Tables 7 and 8. It turns out that the estimated coefficients are close to the heteroscedasticity corrected OLS estimates appearing in Tables 4 and 6. Actually, the spillover effects estimated with IV keep their significant positive sign, hence supporting the robustness of our estimations. No noticeable differences in the parameter estimates of the other variables were observed.

V. Concluding remarks

The effect of FDI on host economies, through increases in their productive efficiency, is an interesting and timely research subject. While a positive overall effect is suggested in the relevant literature under certain conditions, its changing nature according to firm size and degree of foreign ownership was not reported until now.

Using a sample of 3742 Greek manufacturing firms operating in 1997, 5.5% of which are foreign (fully or partially) owned, it was found that foreign firms are more productive than domestic firms and this difference increases the higher the foreign ownership share. The difference actually becomes significant for firms with a foreign share exceeding 51% and only for the group of large firms. When spillovers are taken into account, while a general positive net effect is expected, it becomes evident following our estimations that significant positive spillovers stem only from firms with minority foreign ownership and are enjoyed exclusively by the small firm group.

Large firms do not benefit from any positive externalities, which is confirmed when estimating the differentiated effects exercised by large and small foreign firms as well. In this case, while it is found that large foreign firms are more efficient than

[21] It is surprising though that, despite the availability of panel data in some empirical studies on FDI productivity spillovers, no proper dynamic panel analysis has been employed to deal with the

their small counterparts, it is small foreign firms that seem to interact mostly with domestic firms and transfer new technology, causing the largest spillovers.

Policy suggestions to host countries should stress that in small open economies at an advanced development stage like Greece, where large domestic firms are probably quite competitive being familiar with import and export procedures, productivity spillovers from FDI occur exclusively for small firms. Such spillovers become important when joint ventures with domestic firms are formed where the foreign partner does not have full control. Appropriation of technology know-how by local agents looks then more feasible. Also small foreign firms, being probably not as self-sufficient as their large counterparts, promote technology diffusion because they need to interact with small local agents, which become the recipients of such externalities. Hence, it may be suggested that policies seeking to attract FDI and create long-run positive effects for host economies should aim preferably at small joint ventures where local partners have an increased presence.

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endogeneity problems (see, e.g. Aitken and Harrison, 1999; Girma et al., 2001).

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Table 1: *Industry and size distribution of domestic and foreign firms in Greece, 1997*

	Industrial sectors	All firms	Domestic		Foerign		Large Firms			
							Domestic		Foreign	
			Number	%	Number	%	Number	%	Number	%
1	Food,beverage, tobacco	879	830	94.4	49	5.6	270	32.5	33	67.3
2	Chemicals	224	173	77.2	51	22.8	47	27.2	41	80.4
3	Textiles, clothing, leather	679	664	97.8	15	2.2	192	28.9	14	93.3
4	Machinery equipment	135	130	96.3	5	3.7	10	7.7	4	80.0
5	Basic metals	344	329	95.6	15	4.4	89	27.1	12	80.0
6	Wood, paper, printing & publishing	432	416	96.3	16	3.7	94	22.6	8	50.0
7	Oil refineries & coal	24	20	83.3	4	16.7	8	40.0	3	75.0
8	Plastic & rubber	224	213	95.1	11	4.9	53	24.9	9	81.8
9	Electric machinery	152	137	90.1	15	9.9	36	26.3	10	66.7
10	Transport equipment	100	94	94.0	6	6.0	27	28.7	2	33.3
11	Non-metallic minerals	399	383	96.0	16	4.0	69	18.0	10	62.5
12	Other	150	146	97.3	4	2.7	21	14.4	3	75.0
	Total	3742	3535	94.5%	207	5.5%	916	25.9%	149	72.0%

Table 2: *Number, productivity and total assets of domestic and foreign firms, Greece 1997*

Number of Firms					
Sample	All	Domestic	Foreign	Majority	Minority
Total	3742	3535	207	113	94
Small	2677	2619	58	25	33
Large	1065	916	149	88	61
Y/L (mean values*)					
Total	26.224	25.071	45.920	48.970	42.252
Small	25.047	24.898	31.774	37.029	27.793
Large	29.183	25.565	51.426	52.363	50.074
Total Assets (mean values*)					
Total	2395	1878	11222	13303	8719
Small	590	580	1022	1163	914
Large	6935	5592	15192	16752	12942

* In million drachmas.

Table 3: *Productivity and foreign ownership: direct effects*

Independent variables	Dependent variable: ln(Y/L) of all firms					
	All firms		Small		Large	
	1	2	3	4	5	6
C	5.793	5.782	4.681	4.665	4.754	4.771
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
lnKL	0.369	0.369	0.234	0.234	0.466	0.468
	(0.00)	(0.00)	(0.00)		(0.00)	(0.00)
FDI	0.228	-	0.058	-	0.316	-
	(0.00)		(0.64)		(0.00)	
FMAJ	-	0.219	-	0.070	-	0.293
		(0.00)		(0.56)		(0.00)
FMIN	-	-0.026	-	-0.160	-	0.082
		(0.68)		(0.13)		(0.21)
SCALE	0.093	0.094	0.265	0.266	0.108	0.105
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
DEBT	0.087	0.088	0.084	0.084	0.061	0.062
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
LIQ	1.076	1.076	0.904	0.904	1.261	1.262
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$\overline{R}_2$	0.435	0.435	0.391	0.391	0.639	0.639
Log-likelihood	-3524.40	-3523.77	-2598.88	-2597.67	-759.28	-759.12
Obs.	3742		2677		1065	

Notes:

1.Numbers in parentheses are the p-values. For statistically significant parameter estimates, values of $p \leq 0.05$ are required.

2. All regressions were performed with 19 two-digit industry dummies, the inclusion of which was based on the F-statistic. The excluded dummy corresponds to the last category of miscellaneous manufacturing industries.

3. Small firms employ ≤50 persons, while large firms employ more than 50 persons.

Table 4: *Productivity and foreign ownership: direct and spillover effects*

Independent variables	Dependent variable: ln(Y/L) of all firms											
	ALL				SMALL				LARGE			
	1	2	3	4	5	6	7	8	9	10	11	12
C	5.509	5.664	5.500	5.659	4.191	4.304	4.181	4.301	4.796	4.813	4.801	4.816
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
KL	0.385	0.385	0.385	0.385	0.243	0.243	0.243	0.243	0.475	0.475	0.477	0.477
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
FDI	0.218	0.224	-	-	0.081	0.078	-	-	0.317	0.318	-	-
	(0.00)	(0.00)			(0.526)	(0.61)			(0.00)	(0.00)		
FMAJ	-	-	0.211	0.217	-	-	0.090	0.088	-	-	0.944	0.295
			(0.00)	(0.00)			(0.47)	(0.55)			(0.00)	(0.00)
FMIN	-	-	-0.024	-0.025	-	-	-0.145	-0.147	-	-	0.082	0.082
			(0.71)	(0.70)			(0.18)	(0.22)			(0.22)	(0.24)
FK	0.893	-	0.891	-	1.380	-	1.363	-	-0.087	-	-0.063	-
	(0.00)		(0.00)		(0.00)		(0.00)		(0.79)		(0.84)	
FKMAJ	-	0.345	-	0.327	-	0.967	-	0.924	-	-0.140	-	-0.110
		(0.38)		(0.40)		(0.07)		(0.09)		(0.80)		(0.84)
FKMIN	-	1.473	-	1.488	-	1.743	-	1.749	-	-0.011	-	0.004
		(0.00)		(0.00)		(0.01)		(0.01)		(0.97)		(0.49)
SCALE	0.088	0.087	0.088	0.088	0.265	0.265	0.267	0.266	0.104	0.104	0.102	0.102
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
DEBT	0.089	0.089	0.089	0.090	0.086	0.086	0.086	0.087	0.063	0.063	0.064	0.064
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
LIQ	1.090	1.089	1.090	1.888	0.915	0.914	0.914	0.914	1.269	1.268	1.270	1.269
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$\overline{R}^2$	0.439	0.439	0.439	0.439	0.397	0.397	0.397	0.397	0.649	0.640	0.641	0.640
Log-Likelihood	-3355.02	-3353.73	-3354.39	-3353.03	-2451.40	-2451.06	-2450.41	-2450.02	-738.22	-738.21	-738.09	-738.08
Obs.	3742				2677				1065			

Notes: See Table 3.

Table 5: *Productivity and foreign ownership: spillover effects on domestic firms*

Independent variables	Dependent variable: ln(Y/L) of domestic firms					
	ALL		SMALL		LARGE	
	1	2	3	4	5	6
C	5.661	5.851	4.178	4.272	5.22	5.323
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
KL	0.375	0.376	0.236	0.237	0.464	0.463
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
FK	0.780	-	1.375	-	-0.468	-
	(0.00)		(0.00)		(0.22)	
FKMAJ	-	0.117	-	1.032	-	-0.778
		(0.80)		(0.07)		(0.32)
FKMIN	-	1.422	-	1.671	-	-0.121
		(0.01)		(0.01)		(0.87)
SCALE	0.084	0.082	0.269	0.269	0.091	0.090
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
DEBT	0.088	0.089	0.087	0.087	0.050	0.050
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)
LIQ	1.056	1.054	0.882	0.882	1.238	1.234
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$\overline{R}_2$	0.406	0.406	0.392	0.392	0.594	0.594
Log-likelihood	-3180.38	-3178.89	-2387.09	-2386.88	-634.85	-634.68
Obs.	3535		2619		916	

Notes: See Table 3.

Table 6: *Productivity and foreign firm size: direct and spillover effects*

Independent Variables	Dependent variable: ln(Y/L)							
	ALL			DOMESTIC	SMALL		LARGE	
	1	2	3	4	*ALL* 5	*DOMESTIC* 6	ALL 7	*DOMESTIC* 8
C	5.708	5.11	5.523	5.676	4.218	4.207	4.860	5.251
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
KL	0.370	0.385	0.384	0.375	0.243	0.236	0.475	0.463
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
FDI	-	-	-	-	0.081	-	0.311	-
					(0.61)		(0.00)	
FDISM	0.188	0.205	0.204	-	-	-	-	-
	(0.12)	(0.12)	(0.12)					
FDILG	0.242	0.222	0.220	-	-	-	-	-
	(0.00)	(0.00)	(0.00)					
FK	-	0.891	-	-	-	-	-	-
		(0.00)						
FKSM	-	-	1.087	1.059	1.862	1.946	0.371	0.215
			(0.00)	(0.03)	(0.00)	(0.00)	(0.53)	(0.77)
FKLG	-	-	0.844	0.721	1.289	1.273	-0.253	-0.631
			(0.00)	(0.00)	(0.00)	(0.00)	(0.49)	(0.11)
SCALE	0.093	0.088	0.088	0.084	0.266	0.267	0.106	0.093
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
DEBT	0.087	0.089	0.089	0.089	0.086	0.086	0.062	0.048
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
LIQ	1.076	1.090	1.090	1.056	0.915	0.914	1.273	1.244
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$\overline{R}^2$	0.435	0.439	0.438	0.406	0.396	0.392	0.641	0.594
Log-Likelihood	-3524.32	-3355.01	-3354.89	-3180.18	-2451.03	-2386.61	-737.77	-634.31
Obs.	3742			3535	2677	2619	1065	916

Notes: See Table 3.

Table 7: *IV estimates corresponding to Table 4*

Independent variables	Dependent Variable: ln (Y/L) of all firms					
	ALL		SMALL		LARGE	
	1	2	3	4	5	6
FDI	0.454		0.267*		0.301	
FMAJ		0.382		0.526*		0.386
FMIN		0.193*		0.141*		0.259*
FK	0.456		0.375		0.435*	
FKMAJ		0.326*		0.336*		0.402*
FKMIN		1.819		2.091		1.431*

Notes:

1. The estimations were run including all independent variables appearing in Table 4, but only the coefficients of efficiency shifts (FDI, FMAJ/FMIN) and spillovers (FK, FKMAJ/FKMIN) from FDI are reported for simplicity.
2. P-values (not reported) are ≤ 0.05. When > 0.05 the coefficient is denoted by an asterisk.
3. Number of observations is 2390.

Table 8: *IV estimates corresponding to Table 6*

Independent Variables	Dependent Variable: in (Y/L)							
	ALL			DOMESTIC	SMALL		LARGE	
					ALL	DOMESTIC	ALL	DOMESTIC
	1	2	3	4	5	6	7	8
FDI					0.427		0.427	
FDISM	0.368*	0.337*	0.335*					
FDILG	0.349	0.278	0.278					
FK		0.429						
FKSM			2.743	3.710	3.763	4.214	0.045	1.112
FKLG			0.401	0.306	0.291	0.248	0.571*	0.365*

Notes:

1. The estimations were run including all independent variables appearing in Table 4, but only the coefficients of efficiency shifts (FDI, FDISM/FDILG) and spillovers (FK, FKSM/FKLG) from FDI are reported for simplicity.
2. P-values (not reported) are ≤ 0.05. When > 0.05 the coefficient is denoted by an asterisk.
3. Number of observations is 2390.