TI 2005-101/4
Tinbergen Institute Discussion Paper

Testing for Marginal Spillovers from Foreign Direct Investment

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Testing for marginal spillovers from foreign direct investment

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October 27, 2005

Abstract

We develop a simple test to assess whether horizontal spillover effects from multinational to domestic firms are endogenous to the market structure generated by the entry of the same multinationals. In particular, we analyze the performance of a panel of 10,650 domestic and multinational firms operating in Romania in the period 1995-2001. Controlling for the simultaneity bias in productivity estimates through semi-parametric techniques, we find that changes in domestic firms' TFP are positively related to the first foreign investment in a specific industry and region, but get significantly weaker and become negative as the number of multinationals that enter in the considered industry/region increases. We can thus recover evidence of changing marginal effects in domestic firms' TFP, the sign of which depends on a specific threshold in the presence of foreign firms.

JEL classification: F23; L10; P20

Keywords: multinational firms, productivity, transition economies.

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‡**Acknowledgements**: We wish to thank Rene Belderbos, Davide Castellani, Chiara Criscuolo, Alberto Pozzolo and seminar participants at the 2005 CNR Workshop in International Economics (Urbino, Italy), the 32nd EARIE Conference in Porto and the 7th ETSG meeting in Dublin for helpful comments and suggestions. The usual disclaimer applies.

1 Introduction

The debate on the existence of productivity spillovers from foreign direct investment (FDI), taking place through contacts between multinational (MNE) and domestic firms, is a hot topic in the economic literature. The outcome of the debate is also very relevant in terms of policies: a confirming stance is often taken as a justification of expensive incentive packages for the attraction of foreign investors, while the evidence of negative effects is likely to nurture protectionist arguments. Nevertheless, empirical studies have not come up with a clear answer to the question whether domestic firms benefit from foreign investors or not.

Pioneering empirical studies on sector-specific data by Caves (1974), Globerman (1979), Blomstrom and Persson (1983) and Blomstrom (1986) generally conclude that there are indeed positive productivity spillovers from FDI to domestic firms. Aitken and Harrison (1999) criticize the methodology of the sectoral studies where positive spillovers were found, by arguing that foreign investments primarily occur in sectors where domestic total factor productivity (TFP) is already high, thus leading to a critical identification problem. Using panel data on Venezuelan plants and controlling for fixed differences in productivity levels across industries, they find no significant intra-industry spillovers from foreign firms on domestic firms. Other studies with firm-level panel data also failed to identify positive spillovers from FDI, leading Gorg and Greenaway (2004), in their extensive survey of this literature, to point out the inconclusive evidence emerging from several empirical contributions on the issue[1].

More recently, Smarzynska Javorcik (2004), working on Lithuanian firm-specific data, has detected significant positive spillovers arising through backward linkages, i.e. generated through contacts between multinational affiliates and local input suppliers (vertical spillovers). She finds instead no clear evidence in favour of either intra-industry effects (horizontal spillovers), or forward linkages. Similar results have been obtained by Blalock and Gertler (2004) on a sample of Indonesian firms. In particular this latter generation of papers, in addition to the endogeneity problem, successfully addresses a series of other methodological issues not fully taken into account by the previous literature, namely the selection bias that might arise from the entry and exit of firms given the unbalanced panel nature of the datasets, and the simultaneity bias induced by productivity shocks correlated with firm-level input usage.

And yet the finding in the recent literature of positive vertical spillovers and no, or even negative, horizontal ones poses a puzzle, since, as argued by Alfaro and Rodriguez-Clare (2004),

[1]For example the studies of Haddad and Harrison (1993) on Morocco, of Djankov and Hoekman (2000) on the Czech Republic, and of Konings (2001) on Bulgaria, Poland and Romania, either fail to find a significant positive effect or even detect a negative impact that multinational corporations generate on the performance of domestic firms in the same sector. The situation is slightly different for developed countries, where some studies have found evidence of positive intra-industry spillovers (e.g., Haskel, Pereira and Slaughter, 2002, using UK plant level data).

if multinational firms generate positive externalities to domestic suppliers, the increase in the quality of inputs they produce should also lead to increases in TFP of downstream domestic firms.

Under the latter lines of argument, the lack of positive horizontal spillovers is clearly counter-intuitive. One therefore wonders whether the standard model designs used insofar by the economic literature to detect them are appropriate. In general, all the previously quoted studies measure horizontal spillovers by regressing, within a panel structure, some indicator of productivity of domestic firms against an indicator of 'presence' of MNEs in the same industry[2]. By looking at the average sign and significance of this coefficient, inference is then made on the presence or not of horizontal spillovers and their impact on the performance of domestic firms.

The key issue, however, is that any single ex-post measure of spillovers within a panel structure is the result of two sources of variation: the sign of the effect of MNEs' entry across the observational units, and the change in the sign of these effects over time. In other words, the marginal impact of MNEs on the performance of domestic firms is not necessarily always positive or negative over time, due to the changing market structure induced by the entry of new firms. So, in order to assess whether a domestic firm benefits from foreign entry, the dynamics generated by the changing number of foreign entrants seem important.

More specifically, we know that the presence of a MNE might entail, through various channels (technological or pecuniary externalities), a positive horizontal spillover, i.e. a reduction in the marginal cost of production for domestic firms in the same industry, and thus an increase in their TFP. At the same time, a negative competition effect induced by the entry of a MNE can occur. In the product market, the domestic firm's output could be crowded out by the foreign competitor. Given a slow adjustment in inputs due to adjustment costs, or a partial usage of capital, unobserved by the econometrician, total factor productivity might tend to decrease after the entry of a competitor. In the labor market, foreign firms may attract the higher-skilled workers at the detriment of domestic firms, since MNEs tend to pay higher wages (e.g. Aitken et al., 1996), thus providing another channel through which the entry of a foreign firm may negatively affect domestic TFP. In a cross-sectional regression, these two contrasting forces will determine the outcome in terms of performance changes of domestic firms, and thus our assessment on the existence and sign of horizontal spillover.

Nevertheless, to properly evaluate horizontal spillovers in a panel design, we also need to consider the combined dynamics of these effects, for which we have no priors. If positive horizonal spillovers are present, and the production frontier of domestic firms is below the frontier of

[2] In the 'horizontal' case, the most commonly used indicator of MNEs' presence is the share of MNE's employment over total employment within the considered industry. Such a practice might be itself subject to some criticism, as discussed in the next sections.

foreign firms, we can eventually expect a convergence in total factor productivity of domestic firms towards the foreign ones as more MNEs enter in the local market yielding decreasing positive spillovers[3]. However, the same increasing presence of multinationals might affect the size of the negative competition effect in different directions: one can expect the negative effects to grow larger with MNEs' entry, or it could be the case that the surviving local competitors adapt their production processes to the changing market conditions, with domestic firms' TFP thus increasing as more MNEs enter. As a consequence of these dynamics, the outcome in terms of performance of domestic firms is not constant, but rather endogenous to the market structure generated by the progressive entry of new firms. Therefore, an assessment of horizontal spillovers based on the sign and significance of a single coefficient within a panel regression could lead to biased and, as it is often the case, insignificant results.

These dynamic effects, which could be at the origin of the previously quoted puzzle, have not been properly taken into account in the literature[4]. Thus, the aim of this paper is to test more precisely the nature of the relation between the changes in the cumulate number of foreign investments and the changes in productivity of domestic firms. In particular, we develop a simple framework to test for the existence of a threshold number of foreign investors below which horizontal spillovers are positive, and above which there is a negative marginal effect on domestic TFP (or the other way round). If such a threshold exists for a positive number of MNEs, we can conclude that the concept of 'marginal' spillovers becomes relevant, i.e. the combined effects of positive horizontal spillover and competition on domestic firms' TFP are not constant, but rather varying with the progressive entry of new MNEs. The direction of variation (from positive to negative or the other way round) is then assessed by looking at the signs of the coefficients.

The prediction of a non-constant marginal effect is tested on a sample of indigenous firms in Romania during the period 1995-2001 using firm-specific FDI data which start in 1990. As FDI was virtually prohibited before the fall of the Berlin Wall in 1989, the sample allows us to track MNEs from the very first investment on. Anticipating our results, we find that in Romania a positive threshold number of MNEs exists around which the impact on domestic firms' TFP changes from positive to negative, thus highlighting the relevance of marginal spillovers. Moreover, we also find this threshold to be industry-specific.

These results allow us to partially solve the apparent puzzle surrounding the existence of

[3]For example, in their studies of UK establishments Griffith et al. (2002) find that increased foreign presence within an industry is correlated with productivity growth in domestic establishments through an increased speed of technology transfer, ultimately leading to a convergence of domestic firms' TFP to the technology frontier.

[4]The only exception we are aware of is Sabirianova et al. (2005), who interact the indicator of foreign presence with time dummies in their panel regression in order to retrieve time-varying effects. While they find spillovers to be significantly different over time, they however do not perform any specific testing on the nature of these dynamic effects.

horizontal spillovers. If marginal effects are relevant, i.e. if a positive FDI threshold exists, then standard model designs testing for horizontal spillovers are not appropriate, since they are likely to generate biased and/or insignificant results. Standard inference on horizontal spillovers through the traditional model designs can instead be done once marginal spillovers are proven to be insignificant. The results also shed new light on policy recommendations for attracting foreign investors. If marginal spillovers are relevant and, as it is the case for Romania, the effects on domestic firms are initially positive and then declining as more MNEs enter, then FDI attraction policies should focus on industries where there is no or little foreign presence, since in these sectors the positive spillover effect is likely to outweigh the negative competition effect.

The rest of the paper is organized as follows. The next section discusses the investment and TFP data employed in the analysis, while section 3 presents our methodology. Section 4 analyzes the empirical results and performs some robustness checks. Finally, section 5 concludes with the findings and some future lines of research.

2 The Romanian dataset

Our dataset is composed of domestic firms and affiliates of multinational enterprises operating during the period 1995-2001 in Romania, as retrieved from AMADEUS. The latter is a comprehensive, pan-European database developed by a consulting firm, Bureau van Dijck. It contains balance sheet data in time series on 7 million public and private companies in 38 European countries (2004 edition). The dataset comes as a modular product: a version including the top 250,000 companies, the top 1.5 million (employed in this paper) or all 7 million companies in the considered countries. In the case of Romania, the dataset reports information retrieved by the Romanian Chamber of Commerce and Industry, the institution to which all firms have to be legally registered and report their balance sheet data. In particular, the 'intermediate' version of AMADEUS used in this paper includes data on 30,148 firms for Romania (2004 edition).

For every firm we have sought information on its location within each of the eight Romanian regions and the industry in which these firms operate (at the NACE-2 and 3 level, as reported in the Statistical Annex), as well as yearly balance sheet data on tangible and intangible fixed assets, total assets, number of employees, material costs and revenues (turnover). Moreover, we have gathered information on the year of incorporation in order to distinguish between firms which have always been operating in the considered time span and firms which have entered over the period, thus controlling for a possible sample selection bias resulting from unbalanced panel data, in line with the previous literature. Exiting firms are also considered, recording as exiters those firms which do not report any information after a given year. Finally, we have included in the sample only those firms for which detailed information on the ownership structure is available: in particular, we have considered a firm as foreign if more than 10 per cent of its capital belongs to a MNE, and domestic otherwise.

This has yielded a total of 10,650 employable firms, 30 per cent of which are MNEs in year 2001. The entry and exit dynamics of our sample are reported in Table 1: as it can be seen, the entry rates of our sample match very closely the official entry rates recorded by the Romanian Chamber of Commerce in the considered period. The lower exit rates reported in our sample are likely due to the large-firm bias of the dataset, since larger firms on average tend to benefit from softer budget constraints and display higher survival rates than small firms. The distribution over time and across industries of MNEs is reported in Table 2[5].

In terms of validation, we have retrieved from our sample a yearly measure of regional output, summing the individual firms' revenues operating in each region. We have then correlated these figures so obtained with the official regional figures for Romania, obtaining a significant positive correlation of 0.83[6]. As a result our firm-level data seem to belong to an unbiased sample, being able to reproduce the actual evolution of output in Romania.

[Table 1 and 2 about here]

3 Methodology

To calculate domestic firm-specific productivity estimates, we have first deflated our balance sheet data using a total of 48 NACE2 or NACE3 industry-specific price indices retrieved from the Eurostat New Cronos database, according to the classification reported in the Statistical Annex [7]. We have proxied output with deflated sales, given the better quality of these time series with respect to the ones reporting value added. The number of employees has been used as a proxy for the labour input, and the deflated value of tangible fixed assets as a proxy for capital. We have then reaggregated our initial classification of industries at the NACE2 level[8], estimating within each industry semi-parametric productivity measures at the firm level.

[5]Information on the FDI stock up to 1994 has been retrieved from the PECODB dataset, a firm-specific collection of 4,200 FDI operations undertaken in the countries of Central and Eastern Europe in the period 1990-2002, also based on AMADEUS data and developed by ISLA-Bocconi University. In terms of validation, the database is able to account for almost 70 per cent of the region's total FDI inward stock in the early years of transition, as registered by official statistics.

[6]Since our sample does not include all NACE industries (in particular agriculture), we have subtracted from official regional GVA data the output of those industries not present in our dataset. The correlation between our sample and the official regional data comprising all NACE industries is instead 0.73.

[7]The classification allows to divide industries into economies of scale, traditional, high tech and specialised industries, plus services, according to Pavitt (1984). The same classification has been used by Davies and Lyons (1996) to divide industries into high, medium and low sunk costs. As such, the classification allows us to consider market structures, and hence prices, as relatively homogeneous within each industry.

[8]Firm-specific TFP estimates have been calculated for the 1995-2001 period within each NACE2 industry, in order to ensure an adequate number of observations for each productivity estimate. In a few cases (i.e. NACE16,

In fact, using ordinary least squares when estimating productivity implies treating labor and other inputs as exogenous variables. However, as pointed out by Griliches and Mareisse (1995), profit-maximizing firms immediately adjust their inputs (in particular capital) each time they observe a productivity shock, which makes input levels correlated with the same shocks. Since productivity shocks are unobserved to the econometrician, they enter in the error term of the regression. Hence, inputs turn out to be correlated with the error term of the regression, and thus OLS estimates of production functions are biased. Olley and Pakes (1996) and Levinsohn and Petrin (2003) have developed two similar semi-parametric estimation procedures to overcome this problem.

The use of the latter procedure (see Annex 1 for further details) has allowed us to solve the simultaneity bias affecting standard estimates of firm-level productivity, as well as to derive TFP estimates from heterogeneous, industry-specific production functions. In order to check the appropriateness of our correction for simultaneity, Table 3 reports, for a sample of NACE2 industries, the clear bias that emerges when confronting the results of the semi-parametric estimates of domestic firms' productivity with standard OLS results.

[Table 3 about here]

Since our aim is to measure the impact of the MNEs' presence on the average domestic firm, we have opted for a balanced panel design, aggregating firm-specific TFP measures across the 48 industries and 8 regions over the years 1995-2001, thus using as a dependent variable the average TFP of industry i and region j at time t calculated over individual firms. More importantly, the latter treatment of the dependent variable allows us to minimize potential biases in our TFP measure deriving from the heterogeneity in the mark-ups faced by individual firms[9].

In terms of model design, we have related our dependent variable to the presence of MNEs in the industry-region pair. A common measure of the latter variable, widely used in the literature, is the share of MNE's employment over total employment within the considered industry/region in each year, or its change over time. However, measures of this kind imply that an equiproportional increase in MNEs' presence and total employment (thus yielding a constant share) will have no effect on domestic firms' productivity. If the absolute values of

20 and 65) industries have displayed insufficient variation to identify the input coefficients. Accordingly, TFP measures from firms belonging to these industries have not been considered in the follow-up of our exercise.

[9] Since the seminal paper of Klette and Griliches (1996), it is known that proxying physical inputs and outputs through nominal variables deflated by a broad price index might lead to biased productivity measures, due to an omitted price variable bias induced by the correlation between firms' prices and their used inputs. Katayama, Lu and Tybout (2003) argue that taking industry and region-specific averages on firm-specific measures allows to partially counter this criticism, since the cross-producer variation in productivity measures is much more problematic than the temporal variation of the population of plants.

the elasticities of foreign and total employment are different, Castellani and Zanfei (2003) have shown that using only the ratio of foreign to total employment downwardly biases the estimate of the coefficient.

As a result, we have opted for a model design where the presence of MNEs is identified by the number of the same multinationals operating in a given industry/region in a given year. In particular, since we want to capture the marginal effects on domestic firms'TFP of a change in the presence of MNEs, we shall estimate the following regression equation:

$$\Delta \ln(TPF_{ijt}) = \alpha D_{ijt-1} + \beta D_{ijt-1} CumFDI_{ijt-1} + \gamma_i + \gamma_j + \gamma_t + \varepsilon_{ijt} \tag{1}$$

where D_{ijt-1} is a dummy variable related to the change in the number of MNEs, taking value 1 if an investment is undertaken in sector i of region j in year $t-$ 1, and $CumFDI_{ijt-1}$ is the cumulated number (in logs) of foreign investments in sector i of region j at time $t-1$. The coefficient α thus captures the average effect of a change in the MNEs' presence, while the coefficient β, which refers to the interaction of the investment dummy D_{ijt-1} with the cumulated number of FDI, captures the marginal effects on domestic firms' TFP.

In our specification we have to take care of a number of econometric concerns. First of all, we control for endogeneity and unobserved time, region and industry-specific characteristics that might affect the correlation between firm productivity and foreign presence by first differencing the (log of) the dependent variable, i.e. using $\Delta \ln(TPF_{ijt})$, by lagging one period the MNEs-related variables and by including industry, region and time fixed effects γ_i, γ_j and γ_t, respectively.

Another econometric concern is related to the nature of $CumFDI$, a count variable which in principle treats as equal FDI in different industries, i.e. MNEs which are likely to be characterized by different firms' sizes. If there is a systematic difference over time in the size of MNEs which enter in each industry, ignoring it might lead to potential spurious correlations, not entirely captured by our fixed-effects. However, having calculated the median size of the MNEs that have entered in each industry in each year, we can rule out specific trends over time in this variable, and thus we can exclude that our results are driven by particular dynamics of specific industries. Finally, the cumulated number of foreign investments is a variable increasing over time, and hence non-stationary. Although the variable enters in our specification always interacted with the investment dummy and time-effects are included in our regression, we could still get a positive spurious relation between TFP and foreign presence, as well as problems with the asymptotic properties of our estimators, if there is serial correlation in the error terms. Though the econometric literature in general acknowledges (e.g. Baltagi, 2001) that the problem is negligible in micro panels such as ours, characterized by a large number of cross-sectional units (48*8 in our case) with respect to time (6 years), we report the modified version of the Durbin-Watson statistic for balanced panels, as proposed by Bhargava et al. (1982), in order to assess the extent of the problem for each model specification.

A positive horizontal spillover from MNEs entry on domestic productivity is obtained, in principle, when $\alpha + \beta CumFDI_{ijt-1} > 0$. More specifically, we can check if spillovers are on average positive (negative), i.e. a positive (negative) and significant α, but decreasing (increasing) as more MNEs enter, i.e. a negative (positive) and significant β, the parameter controlling for the marginal effects[10]. The ratio $\frac{\hat{\alpha}}{\hat{\beta}}$ derived from our model design is then a useful statistic to test the relevance of marginal spillovers.

In particular, the critical value of the number of foreign investors that determines the sign of the aggregate spillover can be calculated setting $\alpha + \beta CumFDI_{ijt-1} = 0$. E.g., if $\alpha > 0$, $\beta < 0$ and $-\frac{\alpha}{\beta}$ is significantly different from 0, there exists a threshold value $CumFDI^* = -\frac{\alpha}{\beta}$ of FDI below which aggregate spillovers are positive. Spillovers then become negative as soon as MNEs' entry proceeds.

As a refinement of the previous specification, we specify an industry-specific threshold $CumFDI_i^*$. In fact, in the already quoted paper by Aitken and Harrison (1999), it is claimed that one should distinguish between large and small domestic firms, since it is more likely that industries characterized by larger firms will possess a sufficient level of absorptive capacity to benefit from the presence of FDI. We have thus refined our model specification so that the threshold depends on MES_i, the minimum efficient scale[11] of industry i, as follows:

$$\Delta \ln(TPF_{ijt}) = \alpha D_{ijt-1} + \beta D_{ijt-1} \frac{CumFDI_{ijt-1}}{MES_i} + \gamma_i + \gamma_j + \gamma_t + \varepsilon_{ijt} \quad (2)$$

The intuition explored in model (2) is that industries characterized by larger firms (i.e. a higher MES) should exhibit a higher critical threshold level of FDI after which their spillover becomes negative. Interacting $CumFDI$ and MES as reported yields in fact a critical value of the (industry-specific) threshold $CumFDI_i^* = -\frac{\alpha}{\beta} MES_i$, in line with the original intuition of Aitken and Harrison (1999)[12].

Moreover, to include an intercept in the latter linear relationship for the threshold, we can further generalize the model design as

$$\Delta \ln(TPF_{ijt}) = \alpha D_{ijt-1} + \beta D_{ijt-1} \frac{CumFDI_{ijt-1}}{MES_i} + \gamma D_{ijt-1} \frac{1}{MES_i} + \gamma_i + \gamma_j + \gamma_t + \varepsilon_{ijt} \quad (3)$$

[10]Note that when assessing the overall impact of spillover as $\alpha + \beta CumFDI_{ijt-1}$, the coefficient α can be interpreted as the effect of the first investment on domestic firms' TFP changes.

[11]The minimum efficient scale has been calculated as the median employment of the firms in each industry.

[12]Interacting $CumFDI$ and MES in the proposed way essentially implies to assign greater weight to those FDI undertaken in industries characterised by lower barriers of entry (lower MES). We can therefore control for the industries in which the competition effect from MNEs should be *a priori* stronger.

so that the threshold becomes $CumFDI_i^* = -\frac{\alpha}{\beta}MES_i - \frac{\gamma}{\beta}$. In this case, we can then explicitly design a test statistic for both the coefficient of our functional form, $\frac{\alpha}{\beta}$, and its intercept $\frac{\gamma}{\beta}$.

The next section discusses the results of the three model specifications in the case of Romania.

4 Empirical Results

Our results are presented in Table 4. In the first column we test for our Model 1, thus only considering the (log of) cumulated FDI. As it can be seen, the analysis reveals that FDI undertaken at time $t-1$ has a positive and significant impact on the average productivity changes in a given industry/region, providing evidence of positive horizontal spillovers. More specifically, the estimate for α reveals that, on average, the first foreign investment in a specific sector and region increases domestic TFP by almost 3.5%. The effect however decreases as the number of multinational increases (negative sign of the interaction between D_{ijt-1} and $CumFDI$). The critical value, $-\frac{\alpha}{\beta}$, is positive and significantly different from 0 at the 5% level of significance. In particular, the threshold indicates that *negative* spillovers arise on average from the 12th investment on. The modified Durbin-Watson statistic is very close to 2 across all model specifications, indicating no problems of serial correlation in the error terms.

Nevertheless, in the previous model specification the estimate for β is not significantly different from 0, probably due to the industry-specific nature of β. In fact, interacting the cumulated number of FDI with the inverse of minimum efficient scale, calculated as the firms' median employment in each industry, highly reduces the industry heterogeneity and yields significant results, thus confirming our hypothesis (Model 2) of the existence of an industry-specific threshold $CumFDI_i^* = -\frac{\alpha}{\beta}MES_i$. Column 2 of the Table shows that α is still positive and significant, while β is now also significantly different from 0. Moreover, our test statistic $-\frac{\alpha}{\beta}$ is positive and significant.

In order to check whether in our expression for the industry-specific threshold we have omitted an intercept term, we have also included in the regression the term $\gamma D_{ijt-1}\frac{1}{MES_i}$, which implies a threshold $CumFDI_i^* = -\frac{\alpha}{\beta}MES_i - \frac{\gamma}{\beta}$ (Model 3). To avoid multicollinearity, we have instrumented $\frac{1}{MES_i}$, the (inverse of) the industry-specific MES, with $\frac{1}{MES_{ij}}$, i.e. the (inverse of) MES calculated for each industry i and region j. The results are reported in Column 3. Again, both α and β are significant, as it is our test statistic $-\frac{\alpha}{\beta} > 0$, while we cannot reject the hypothesis that the intercept, $-\frac{\gamma}{\beta}$, equals zero at conventional levels of significance.

Following the related literature (e.g. Sinani and Meyer, 2004 or Glass and Saggi, 2002), as a robustness check we have augmented Model 3 with the Herfindahl index calculated for both domestic and foreign firms (Column 4a) or for domestic firms only (Column 4b), with the stock of FDI cumulated at the beginning of our observation period and with the investment in intangible assets in a given industry/region as a proxy for firms' absorptive capacity (Column 5)[13]. Our estimates of α and β are very robust to these different model specifications, as well as our hypothesis of a zero intercept term in our threshold expression.

As a further robustness check, we have recalculated our estimates removing the assumption, implicit in our model specification, that the impact of the MNEs' presence affects domestic firms' productivity only in the year in which the investment by the MNE has been undertaken ($CumFDI$ is multiplied by a flow dummy D which has no 'memory' of past investments). Hence, we have introduced a dummy D' that takes value 1 if an investment has dropped in the considered industry/region in *any* year before t, and 0 otherwise. As shown in Table 5, the results are virtually unchanged, yielding, if anything, a slightly poorer model specification.

[Table 4 and 5 about here]

Based on the estimates of α and β reported in Column 2 of Table 4, we have calculated in Table 6 the industry-specific thresholds of FDI for which the competition effects induced by multinational firms are on aggregate lower than the positive spillovers they generate on the local economy. Technically, given our model design, one should compare the thresholds so obtained with the industry and region-specific cumulated number of FDI, in order to assess the sign of the horizontal spillovers to the local economy. As it can be seen in Table 6, while for some industries more than one FDI in a given industry/region seems to be enough to generate a negative spillover, for other industries the marginal negative effect induced by the entry of further MNEs is still lower than the benefits the latter generate on the local economy.

[Table 6 about here]

5 Conclusion and further lines of research

Our analysis confirms that, in the case of Romania, there exists a (industry-specific) threshold of MNEs driving the results of aggregate spillovers. We can thus conclude that the concept of 'marginal' spillovers becomes relevant, i.e. the combined effects of positive horizontal spillover and competition on domestic firms' TFP are not constant, but rather varying with the progressive entry of new MNEs, with initially positive effects progressively overcome by the increase in the competition from multinationals. As a result, if horizontal spillovers measures are combined in a unique coefficient, measuring the average impact over time of the MNEs' presence on the

[13] In their study of MNEs' spillovers on domestic firms in transition economies, Damijan et al. (2003) find significantly different results when controlling for domestic firms' absorptive capacity as proxied here. However, they employ a different measure of productivity, i.e. output per employee rather than TFP.

productivity of Romanian domestic firms, as the current literature has been doing, it is very likely that the same coefficient is not significant and biased, essentially due to a misspecification in the model which fails to take into account the changes in the market structure induced by the continuous entry of MNEs.

In the case of Romania, the threshold probably reflects the fact that firms in transition countries slowly adapt to more modern production techniques and that high exit barriers prevent the shake out of domestic firms. Clearly, although our findings can explain the puzzling evidence of no significant horizontal spillovers on average, they cannot clarify the nature of the previously quoted empirical evidence of positive spillovers for developed countries (e.g. Haskel, Pereira and Slaughter, 2002). As the number of investors in advanced countries is much higher than in developing countries, one possibility is that there may exist another threshold number of investors above which spillovers become positive. Every study of this kind, therefore, should run a preliminary check on the relevance of marginal spillovers before drawing conclusions on horizontal spillovers.

In terms of policy implications, this study suggests that FDI attraction policies should focus on sectors where the marginal effect of foreign entry is positive, as illustrated in our Table 6 for Romania. In sectors where the number of cumulated FDI is still below the calculated threshold, in fact, the spillover effect is likely to outweigh the competition effect and benefits for the productivity of local firms might be expected. In industries characterized by lower critical FDI thresholds, instead, any new FDI entering the market aggravates negative spillovers to domestic firms.

More in general, however, it still remains to be assessed the precise cause of the decline in the impact of foreign entry on domestic TFP. In other words, while we have realized that, after a given threshold in the FDI presence, the negative competition outweighs the spillover effect, we still do not know the reasons behind the emergence of this threshold.

Especially the competition effect should be the subject of a more thorough investigation. In the Introduction, we have offered a tentative explanation: foreign entry might crowd out domestic firms and hence, given a slow adjustment in inputs due to adjustment costs, reduce their TFP. Alternatively, a lower TFP might be induced by the lower economies of scale accruing to domestic firms given their smaller market sizes, progressively compressed by the presence of the foreign competitors. But the latter explanation will be true only for sectors characterized by increasing returns, a restriction that we have clearly not imposed in our calculation of production functions and TFP. Also strategic decisions of technology transfers by MNEs entering domestic markets should be more carefully studied in order to better understand a possible decline in positive spillovers through the changing nature of technology transfers, endogenous to the market structure[14]. Clearly, a thorough examination of all these possible channels is left to a future research agenda.

[14] For example, in Blalock and Gertler (2004) MNEs have an incentive to widely diffuse technology to their suppliers in order to avoid an hold-up problem. However, since the MNE cannot prevent the upstream suppliers from selling also to the multinational's competitors in the downstream market, if the foreign firm faces too much competition, it will start to strategically reduce its degree of technology transfers. Also Belderbos et al. (2005) find that the decision to invest in R&D in a foreign country by a MNE affects negatively the location decision of similar activities by a rival MNE: as a result, the technological transfer will be interrupted after a certain number of rivals' entries.

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Annex 1: Levinsohn and Petrin (2003) productivity estimates

Let y_t denote (the log of) a firm's output in a Cobb-Douglas production function of the form

$$y_t = \beta_0 + \beta_l l_t + \beta_k k_t + \beta_m m_t + \omega_t + \eta_t \tag{A1.1}$$

where l_t and m_t denote the (freely available) labour and intermediates inputs in logs, respectively, and k_t is the logarithm of the state variable capital. The error term has two components: η_t, which is uncorrelated with input choices, and ω_t, a productivity shock unobserved to the econometrician, but observed by the firm. Since the firm adapts its input choice as soon as she observes ω_t, inputs turn out to be correlated with the error term of the regression, and thus OLS estimates of production functions yield inconsistent results.

To correct for this problem, Levinsohn and Petrin (2003), from now on LP, assume the demand for intermediate inputs m_t (e.g. material costs) to depend on the firm's capital k_t and productivity ω_t, and show that the same demand is monotonically increasing in ω_t. Thus, it is possible for them to write ω_t as $\omega_t = \omega_t(k_t, m_t)$, expressing the unobserved productivity shock ω_t as a function of two observables, k_t and m_t.

To allow for identification of ω_t, LP follow Olley and Pakes (1996) and assume ω_t to follow a Markov process of the form $\omega_t = E[\omega_t|\omega_{t-1}] + \xi_t$, where ξ_t is a change in productivity uncorrelated with k_t. Through these assumptions it is then possible to rewrite Equation (A1.1) as

$$y_t = \beta_l l_t + \phi_t(k_t, m_t) + \eta_t \tag{A1.2}$$

where $\phi_t(k_t, m_t) = \beta_0 + \beta_k k_t + \beta_m m_t + \omega_t(k_t, m_t)$. By substituting a third-order polynomial approximation in k_t and m_t in place of $\phi_t(k_t, m_t)$, LP show that it is possible to consistently estimate the parameter $\widehat{\beta}_l$ and $\widehat{\phi}_t$ in Equation A1.2. For any candidate value β_k^* and β_m^* one can then compute a prediction for ω_t for all periods t, since $\widehat{\omega_t} = \widehat{\phi}_t - \beta_k^* k_t - \beta_m^* m_t$ and hence, using these predicted values, estimate $E[\omega_t|\widehat{\omega_{t-1}}]$. It then follows that the residual generated by β_k^* and β_m^* with respect to y_t can be written as

$$\widehat{\eta_t + \xi_t} = y_t - \widehat{\beta}_l l_t - \beta_k^* k_t - \beta_m^* m_t - E[\omega_t|\widehat{\omega_{t-1}}] \tag{A1.3}$$

Equation (A1.3) can then be used to identify β_k^* and β_m^* using the following two instruments: if the capital stock k_t is determined by the previous period's investment decisions, it then does not respond to shocks to productivity at time t, and hence $E[\eta_t + \xi_t|k_t] = 0$; also, if the last period's level of intermediate inputs m_t is uncorrelated with the error period at time t (which is plausible, e.g. in the case of material costs), then $E[\eta_t + \xi_t|m_{t-1}] = 0$.

Through these two moment conditions, it is then possible to write a consistent and unbiased estimator for β_k^* and β_m^* simply by solving

$$\min_{(\beta_k^*, \beta_m^*)} \sum_h [\sum_t (\widehat{\eta_t + \xi_t}) Z_{ht}]^2 \tag{A1.4}$$

with $Z_t \equiv (k_t, m_{t-1})$ and h indexing the elements of Z_t.

Table 1. The evolution of the panel of Romanian firms. Sample vs. official data

Year	Number of firms			MNEs penetration	Entry Rate		Exit Rate	
	Dom	MNEs	Total		Sample	Official	Sample	Official
1995	4764	1217	5981	0.20				
1996	5449	1504	6953	0.22	0.19	0.11	0.01	0.09
1997	5898	1653	7551	0.22	0.11	0.08	0.01	0.07
1998	6389	1896	8285	0.23	0.10	0.07	0.01	0.07
1999	6957	2121	9078	0.23	0.10	0.06	0.01	0.06
2000	7331	2603	9934	0.26	0.10	0.06	0.00	0.09
2001	7605	3045	10650	0.29	0.08	0.11	0.02	0.10

Source: authors' elaboration on the basis of AMADEUS dataset and Romanian Chamber of Commerce for official data.

Table 2. Cumulative FDI in Romania, 1990-2001.

NACE	Stock 1994	1995	1996	1997	1998	1999	2000	2001
10,14	2	13	24	31	36	42	48	49
151,152	0	6	11	19	21	24	27	29
153,155	0	10	17	26	30	39	44	49
156	0	4	12	19	20	21	21	30
157	0	0	0	1	2	3	4	4
158	0	27	42	61	87	94	106	112
159	6	10	21	24	32	35	39	40
16	0	0	1	2	5	6	7	7
17	1	9	28	54	77	97	109	124
18	4	17	49	80	122	153	180	204
19	0	9	22	39	57	66	83	97
20	1	17	43	80	113	142	172	192
21	0	3	11	14	22	27	33	34
22	0	14	27	39	52	64	70	71
241,242	2	5	13	15	22	27	28	29
243,245	2	6	10	16	22	26	31	35
246,247	1	1	2	2	5	7	7	8
251	0	3	4	6	7	8	8	9
252,262	0	6	16	32	45	53	68	77
26	1	7	14	21	29	34	41	46
27	3	4	7	10	21	26	30	33
28	1	8	18	43	55	70	85	101
291	0	1	2	4	5	7	9	10
292	0	1	2	5	8	10	11	12
293	0	1	2	2	5	5	5	5
294,295	2	4	9	13	15	17	21	27
297	0	0	2	3	3	3	4	4
30	0	3	6	12	14	15	18	21
31	2	6	10	14	21	29	33	47
321	0	0	1	3	5	5	7	10
322,323	1	3	3	5	7	8	11	12
331,332	0	1	2	4	4	6	6	9
334,335	0	0	1	2	2	2	3	3
341	0	0	1	1	1	1	1	1
343	0	0	0	0	0	0	0	0
351	0	0	0	1	1	1	1	1
352,354	1	1	2	2	2	2	2	2
361,362	1	5	16	31	43	48	59	74
363,365	1	2	2	3	7	9	9	10
366	0	1	3	10	15	18	25	30
40	0	0	3	5	7	7	8	10
45	2	19	47	91	144	171	202	224
55	6	7	7	7	7	7	7	7
642	2	2	2	6	6	6	6	6
65,66	2	7	7	7	7	7	7	7
92	0	1	2	2	2	2	2	2

Source: authors' elaboration on the basis of the AMADEUS dataset. See Annex for details on the classification of industries.

Table 3. A comparison of productivity estimates in a sample of NACE2 industries

	NACE2 Industry	**Food**	**Automotive**	**Wood products**	**Rubber and Plastics**
Lev Pet (2003)	ln (labor)	0.0257***	0.0552***	0.0578***	0.0603***
	ln (materials)	0.8436***	0.9756***	0.8547***	0.7672***
	ln (capital)	0.0858***	0.1617***	0.0803***	0.1021***
OLS	ln (labor)	0.1494***	0.2184***	0.2653***	0.2823***
	ln (materials)	0.9199***	0.9224***	0.8992***	0.8927***
	ln (capital)	0.0019	-0.0238	0.0017	-0.0261***
	OLS bias in labor coeff.	+	+	+	+
	OLS bias in material coeff.	+	-	-	+
	OLS bias in capital coeff.	not sign.	not sign.	not sign.	-
	N. of domestic firms	6880	360	3172	1276
	NACE2 Industry	**Metal Products**	**Construction**	**Hotels and Restaurants**	**Telecom**
Lev Pet (2003)	ln (labor)	0.111***	0.1270***	0.1995***	0.2124***
	ln (materials)	0.8939***	0.7120***	0.7010***	0.8772***
	ln (capital)	0.0831**	0.1382***	0.0659	0.0049
OLS	ln (labor)	0.3098***	0.3601***	0.3898***	0.5697***
	ln (materials)	0.8774***	0.8201***	0.7575***	0.7101***
	ln (capital)	-0.0392***	-0.0097**	0.0468***	0.0468***
	OLS bias in labor coeff.	+	+	+	+
	OLS bias in material coeff.	-	+	+	-
	OLS bias in capital coeff.	-	-	not sign.	not sign.
	N. of domestic firms	2821	8697	812	721

Table 4. Marginal spillover effects from FDI – Flow dummy

Dep var.: average change in ln(TFP) (Levinsohn-Petrin semi-parametric estimates)

	(1)	(2)	(3)	(4a)	(4b)	(5)
D_{t-1}	.034* (.02)	.035** (.02)	.056*** (.02)	.056*** (.02)	.056*** (.02)	.056*** (.02)
D_{t-1}*$Cumfdi_{t-1}$	-.014 (.01)					
D_{t-1}*$Cumfdi_{t-1}$/MES		-.25* (.15)	-.26* (.15)	-.26* (.15)	-.26* (.15)	-.26* (.15)
D_{t-1}/MES			-.22* (.13)	-.22* (.13)	-.22* (.13)	-.22* (.13)
Herfindal (all firms)				-.001 (.03)		-.003 (.03)
Herfindal (dom. firms)					.008 (.03)	
FDI Stock 1994						.016 (.02)
Absorptive capacity						.01 (.01)
48 Industry dummies	83.08***	79.85***	80.25***	79.92***	80.46***	77.55***
8 Regional dummies	4.63	4.50	4.58	4.57	4.55	4.99
6 Time dummies	46.64***	48.88***	44.67***	43.01***	44.37***	43.01***
R-sq.	.26	.27	.27	.27	.27	.28
N. of obs.	1802	1802	1802	1802	1802	1802
Modified Durbin-Watson serial correlation test	1.92 (ρ=0.04)	1.92 (ρ=0.04)	1.91 (ρ=0.05)	1.91 (ρ=0.05)	1.92 (ρ=0.05)	1.92 (ρ=0.05)
Spillover test statistic [a] X^2	4.38**	5.80**	5.23**	5.21**	5.28**	5.15**
Intercept test statistic [b] X^2	-	-	1.62	1.61	1.63	1.60

Note: Standard deviation in parentheses. Joint significance tests for industry, region and time dummies.
*, ** or ***: significant at the 10, 5 or 1 per cent level respectively.

(a) Ho: α/β=0 given α D_{t-1} + β D_{t-1}*$Cumfdi_{t-1}$ (Column 1) and α D_{t-1} + β D_{t-1}*$Cumfdi_{t-1}$/MES (Columns 2-5)

(b) Ho: γ/β=0 given α D_{t-1} + β D_{t-1}*$Cumfdi_{t-1}$/MES + γ D_{t-1}/MES

Table 5. Marginal spillover effects from FDI – First investment dummy

Dep var.: average change in ln(TFP) (Levinsohn-Petrin semi-parametric estimates)

	(1)	(2)	(3)	(4a)	(4b)	(5)
D'_{t-1}	.023* (.01)	.024* (.01)	.043** (.02)	.044** (.01)	.044** (.01)	.045** (.02)
$D'_{t-1}*Cumfdi_{t-1}$	-.015 (.01)					
$D'_{t-1}*Cumfdi_{t-1}/MES$		-.27* (.14)	-.29** (.14)	-.29** (.14)	-.28** (.14)	-.29** (.14)
D'_{t-1}/MES			-.22* (.13)	-.22* (.13)	-.22* (.13)	-.22* (.13)
Herfindal (all firms)				-.001 (.03)		-.003 (.03)
Herfindal (dom. firms)					.006 (.03)	
FDI Stock 1994						.018 (.02)
Absorptive capacity						.01 (.01)
48 Sector dummies	85.59***	82.93***	83.55***	82.97***	83.67***	80.44***
8 Regional dummies	4.91	4.89	5.00	4.98	4.99	5.41
6 Time dummies	43.55***	47.61***	44.41***	42.83***	44.17***	43.05***
R-sq.	.27	.27	.27	.27	.27	.28
N. of obs.	1802	1802	1802	1802	1802	1802
Modified Durbin-Watson serial correlation test	1.92 (ρ=0.04)	1.92 (ρ=0.04)	1.92 (ρ=0.04)	1.92 (ρ=0.04)	1.92 (ρ=0.04)	1.92 (ρ=0.04)
Spillover test [a] X^2	2.50	2.82*	3.53*	3.52*	3.52*	3.69*
Intercept test statistic [b] X^2	-	-	1.75	1.74	1.75	1.78

Note: Standard deviation in parentheses. Joint significance tests for sector, region and time dummies.
*, ** or ***: significant at the 10, 5 or 1 per cent level respectively.

(a) Ho: α/β=0 given $\alpha D'_{t-1} + \beta D'_{t-1}*Cumfdi_{t-1}$ (Column 1) and $\alpha D'_{t-1} + \beta D'_{t-1}*Cumfdi_{t-1}/MES$ (Columns 2-5)

(b) Ho: γ/β=0 given $\alpha D'_{t-1} + \beta D'_{t-1}*Cumfdi_{t-1}/MES + \gamma D'_{t-1}/MES$

Table 6. Industry-specific FDI thresholds for positive spillovers

Nace	CumFDI*	*Nace*	CumFDI*
10,14	1	*292*	3
151,152	2	*293*	3
153,155	2	*294,295*	4
156	2	*297*	2
157	7	*30*	3
158	2	*31*	24
159	2	*321*	11
16	2	*322,323*	69
17	2	*331,332*	81
18	2	*334,335*	18
19	3	*341*	1
20	2	*343*	2
21	2	*351*	72
22	1	*352,354*	30
241,242	3	*361,362*	2
243,245	43	*363,365*	3
246,247	16	*366*	3
251	14	*40*	3
252,262	2	*45*	1
26	3	*55*	1
27	11	*642*	3
28	2	*65,66*	13
291	2	*92*	3

Note: CumFDI* = $-\alpha * MES/\beta - \gamma/\beta$ as retrieved from Column 2, Table 4.

See the Statistical Annex for the definition of the NACE codes.

Statistical Annex – Classification of industries

The model includes a total of 48 NACE 2 and 3 digits industries, grouped as follows:

Economies of scale industries: 10-11-12-13 and 14 (mining of coal, metals and stone; extraction of petroleum and natural gas); 21 (paper and pulp); 22 (publishing and press); 241 and 242 (basic chemicals and agro-chemicals); 246 and 247 (other chemical products and synthetic fibres); 251 (rubber products); 26 (other non-metallic products); 27 (metallurgy); 297 (domestic appliances); 31 (electrical appliances, excluding domestic); 321 (electronics); 322 and 323 (communication equipment); 341 (car production); 343 (car components); 351 (ship building); 352 and 354 (railways; motorcycles); 40 (energy)

Traditional industries: 151 and 152 (production and transformation of meat and fish); 153 and 155 (vegetables, milk and dairy products); 156 (grains); 157 (pet food); 158 (fabrication of bread, tea, coffee); 159 (drink and beverages); 16 (tobacco); 17 (textiles); 18 (clothing); 19 (leather); 20 (wood); 28 (metals); 361 and 362 (furniture); 363 and 365 (musical instruments and toys); 366 (other general manufacturing)

Specialized industries; 252 and 262 (plastic products); 291 (mechanical machinery); 292 (general machinery); 293 (agricultural machines); 294 and 295 (machine tools); 334 and 335 (optics, photography, clocks); 45 (construction)

High-tech industries: 243-245 (paintings and pharmaceuticals); 244 (pharmaceuticals); 30 (office machines and computers); 331 and 332 (medical and precision instruments); 642 (telecommunication)

Services: 55 (hotels and restaurants); 65 and 66 (financial intermediation and insurance); 72 (computer and related activities); 73 (research and development); 92 (cultural and sporting activities)