Multinational companies and productivity spillovers: is there a specification error?*

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Abstract

Recent empirical works on the within-sector impact of inward investments on domestic firms' productivity have found rather robust evidence of no (or even negative) effects. We suggest that, among other reasons, a specification error might explain some of these results. A more general specification, which includes the usual one as a special case, is proposed. Using data on Italian manufacturing firms in 1992-2000, we find positive externalities only once we allow for the more flexible specification.

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Introduction

Recent surveys of empirical evidence on productivity spillovers from multinational presence in host countries shows that most studies using firm-year panel data, reported negative or non-significant externalities (Gorg and Stobl, 2001; Gorg and Greenaway, 2004). In this paper we claim that, among other methodological issues[1], a specification bias might have increased the likelihood of zero or negative spillovers.

The main approach used in the literature is to regress labour or total factor productivity of domestic firms on a measure of foreign presence (usually calculated at the sectoral level) and other controls. A common feature of most studies is that the foreign presence variable is measured as the share of foreign to total activity (in a given sector). Foreign and total activity are usually proxied by employment, assets or output. A positive and significant coefficient on the foreign presence variable is taken as evidence of overall positive spillover effects from multinational to domestic firms.

This specification is likely to produce a downward bias on the spillover coefficient. In fact, one implicitly assumes that an increase in the same proportion of activities of foreign firms and of the sectoral aggregate (leaving the ratio unchanged) should cause no effect on domestic firms' productivity. In other words, as we show in subsequent sections, the elasticities of domestic firms' productivity to foreign and total activity are restricted to be equal in magnitude but with inverted signs. When this restriction does not hold, as in the case of Italian manufacturing firms illustrated in this paper, the spillover coefficient may be downward biased. By contrast, a more flexible specification of externalities yields larger (positive and significant) spillover effects. The paper is organized as follows. Section 2 sketches the empirical model and derives the bias which might be associated with measuring spillovers from multinational firms using the foreign presence ratio. Section 3 describes our data, variables and estimation strategy. Section 4 discusses the results and section 5 concludes.

2. An empirical model of externalities from multinational activities in host countries

Let Y be the output produced by a domestic-owed firm, with two sources of externalities, T denoting aggregate activity in sector *j* and F denoting activities of foreign multinationals in sector *j* [2].

$$Y_{it} = B_{it} K_{it}^{\alpha} L_{it}^{\beta} M_{it}^{\gamma} \quad (1)$$
$$B_{it} = e^{c+\eta_i+e_{it}} F_{jt}^{\delta_1} T_{jt}^{\delta_2}$$
$i = 1, \ldots N^d$ (domestic firms)
$j = 1, \ldots J$ (sectors)
$t = 1, \ldots T$ (time)

Notation is as usual: Y is real output, L is the number of employees, K is the stock of capital and M is the use of raw materials and energy. Firms' TFP (B) is modelled simply as a function of the two externality parameters, a fixed effect and an error term. We maintain a very simple structure of the determinants of firms' TFP to avoid complexities in the derivation of the bias below. We admit that economic applications should be able to control for other important factors affecting firms' TFP, such as firms' age, R&D and innovation activities, as well as other time varying firm/sector characteristics[3].

Taking logs, TFP term becomes

$$\begin{aligned} \log B_{it} &= c + \delta_1 \log(F)_{jt} + \delta_2 \log(T)_{jt} + \eta_i + \varepsilon_{it} \\ &= c + \delta_1 \log(F/T)_{jt} + (\delta_1 + \delta_2) \log(T)_{jt} + \eta_i + \varepsilon_{it} \end{aligned} \quad (2)$$

As anticipated in the previous section most existing studies looking for FDI externalities estimate variants of equation (2) where the externality term reduces to the F/T ratio[4], implying that an increase of the same proportion of both T and F (leaving F/T unchanged) should not cause any effect on domestic firms' productivity. In other words, as shown in equation (2), this would require that we impose that $\delta_1 + \delta_2 = 0$. We argue that this is not such an innocent restriction, since it imposes that an increase (decrease) in F and T in the same proportion will have an impact on domestic productivity that is equal in magnitude but opposite in direction. In other words, the restriction entails that either a positive spillover generated by foreign activities is exactly

counterbalanced by a negative spillover of total activities; or, symmetrically, that a positive spillover generated by total activity is exactly counterbalanced by a negative spillover of foreign activity. Neither of these circumstances needs to occur as a rule (even though it might be the case under specific conditions). In fact, the former statement contradicts most of existing theoretical work in the economic growth literature (e.g. Romer, 1986 and Arrow, 1962) and empirical findings (Caballero and Lyons, 1991; Oulton, 1996) which would rather suggest that increases in total activities determine positive productivity effects. On the other hand, if one is willing to accept that aggregate activity determines some positive external effect, the restriction forces spillovers from multinational activity to be negative.

Indeed, one can easily notice that imposing $\delta_1 + \delta_2 = 0$ will most likely cause a downward bias in $\hat{\delta}_1$. First differencing equation (2) wipes out fixed effects and yields

$$\begin{aligned} \Delta \log B_{it} &= \delta_1 \Delta \log(F/T)_{jt} + (\delta_1 + \delta_2)\Delta \log(T)_{jt} + \varepsilon_{it} \\ &= \delta_1 x_{it} + \theta\, z_{it} + \varepsilon_{it} \end{aligned} \tag{3}$$

where we simplified notation by setting $x_{it} = \Delta \log(F/T)_{jt}$, $z_{it} = \Delta \log(T)_{jt}$, and $\theta = \delta_1 + \delta_2$. Whenever $\delta_1 + \delta_2 = 0$ is imposed, i.e. z_{it} is omitted from the regression, equation (3) can be re-written as:

$$\Delta \log B_{it} = \delta_1 x_{it} + u_{it} \tag{4}$$

Where $u_{it} = \theta\, z_{it} + \varepsilon_{it}$ is the new error term. Equation (4) is a simplified version of what is estimated in most of the literature using only the F/T ratio as a measure of foreign presence[5]. From textbook econometrics we obtain (Greene, 1997 p.401-403)[6]:

$$E(\hat{\delta}_1) = \delta_1 + \frac{Cov(x,z)}{Var(x)}\theta = \delta_1 + \frac{Cov[(\Delta \log F/T),(\Delta \log T)]}{Var[(\Delta \log F/T)]}(\delta_1 + \delta_2).$$

To the extent that the restriction imposed in the literature estimating only the F/T ratio is satisfied (i.e. $\delta_1 + \delta_2 = 0$), no bias is produced. Otherwise, since $Var(x) > 0$, the direction of the bias is determined by two terms: *(i)* the sum of the unrestricted coefficients of externalities from

foreign and aggregate sectoral activity and *(ii)* the covariance between $\Delta \log F/T$ and $\Delta \log T$. Therefore, if $\delta_1 + \delta_2 > 0$, the restriction imposed in the literature is likely to produce a downward biased externality coefficient, when $\Delta \log F/T$ and $\Delta \log T$ are negatively correlated. This formalizes an intuition put forward by Aitken and Harrison (1999 p.610, footnote 7, our comments in squared brackets): *"if foreign plants do not adjust quickly to economic downturns, while domestic firms react immediately* [which occurs if $\Delta \log F/T$ and $\Delta \log T$ are negatively correlated], *this would lead us to observe a rising foreign share in periods of economic decline. If productivity is procyclical* [i.e. domestic productivity growth depends on the rate of growth of the sector ($\delta_1 + \delta_2 > 0$)], *we would wrongly infer that foreign investment has a negative impact on domestic productivity"*. As discussed below, the case of firms active in Italy is illustrative of how such a bias can be relevant, and shows that FDI externalities are markedly higher when the restriction is not imposed.

To sum up, our simple empirical model suggests that an omitted variable ($\Delta \log T$) might have biased estimates of productivity spillovers from multinational companies downward in most existing studies, thus increasing the likelihood of negative or non-significant effects.

3. Data and estimation strategy

The case of Italian manufacturing firms is used to test for the existence of the bias identified above. The sample is drawn from Elios (European Linkages and International Ownership Structure), a data-set constructed at ISE-University of Urbino, from the intersection of two commercially available databases: Bureau Van Dijck's Amadeus and Dun & Bradstreet's Who Owns Whom (D&B Linkages) . The overall sample contains 1,197 firms located in Italy, of which 877 are controlled by Italian parents (we define them as domestic) and 320 affiliates of foreign multinationals. Economic and financial data were available for a 9-year time span, from 1992 to 2000.

We estimate a log-linear version of (1), taking first differences to wipe out the fixed effect:

$$\Delta \log Y_{it} = \alpha \Delta \log K_{it} + \beta \Delta \log L_{it} + \gamma \Delta \log M_{it} + \mathbf{E}'_{it}\,\boldsymbol{\varphi} + \Delta \varepsilon_{it} \qquad (5)$$

where Y, K, L and M are respectively output, fixed capital, employment and material use as above[7], while **E** denote the vector of FDI externalities, which we first estimate introducing only $\Delta \log(F/T)_{it}$, as in most existing studies, then control for $\Delta \log(T)_{it}$, as suggested by our empirical model. Finally, as a further check of our model, we introduce $\Delta \log(F)_{it}$ and $\Delta \log(T)_{it}$ as two separate regressors[8].

*** Table about here ***

4. Results

We estimate OLS regression of equation (5) using two different measures of Foreign activity F, and of Total activity T, based on employment, as reported in columns (1), (2) and (3) of the table; and on value added, as reported in columns (7), (8) and (9). As a robustness check, we also allow for the endogeneity of input growth by a GMM-IV estimator where the second lag in inputs, log(F), log(T) and time trend are used as instruments. GMM-IV estimates are shown in columns (4), (5), (6), and (10), (11), (12), with reference to employment and value added data respectively. OLS estimations reported in columns (1), (4), as well as GMM-IV estimations shown in columns (7) and (10) are consistent with most existing evidence based on firm-year panel data: whenever multinational presence is specified as a foreign to total activity ratio (with no control for the size of the market), according to the common practice in empirical literature, productivity spillovers turn out non-significant. Once we allow for the more flexible specification proposed in this paper, we find positive and significant FDI externalities using both employment- and value added-based measures of externality, as shown in the other columns in the table. In fact, as predicted by our simple empirical model, if the correlation between $\Delta \log F/T$ and $\Delta \log T$ is negative and

$\delta_1 + \delta_2 > 0$, estimates of δ_1 are characterised by a downward bias. Our results show that both conditions hold in our data and support our proposal for a more flexible specification of FDI externalities.

5. Conclusions

In recent years most studies using firm-level panel data and controlling for unobserved heterogeneity have found that foreign presence had at most a non significant impact on domestic firms' productivity. This paper has suggested that these findings might be influenced by an incorrect specification. In fact, we found that under mild conditions (in particular negative correlation between the growth rates of the foreign presence ratio and of total sectoral activity) the common practice of modelling multinational presence as the share of foreign to total activities could produce estimates of externalities biased towards zero. Accordingly, using data on Italian manufacturing firms, we find no productivity spillover when the usual specification is adopted; while when controlling for the size of the industry, as suggested by our empirical model, we obtain positive and significant spillovers. These results support the view that moving away from the specification commonly used in the literature will improve our capability to measure the actual impact of foreign presence on domestic performance.

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Table 1 –Within-sector impact of foreign presence on domestic firms productivity in Italy, 1992-2000 (OLS and GMM-IV estimates)

Dependent Variable: $\Delta log(Y)$ Sample: Only Domestic Firms												
Estimation method	OLS	OLS	OLS	GMM-IV	GMM-IV	GMM-IV	OLS	OLS	OLS	GMM-IV	GMM-IV	GMM-IV
Measure of F and T**	L	L	L	L	L	L	VA	VA	VA	VA	VA	VA
	1	2	3	4	5	6	7	8	9	10	11	12
$\Delta log(F/T)^*_{jt}$	.002	.046		.034	.099**		-.050	.089**		-.033	.055**	
	(.022)	(.030)		(.024)	(.033)		(.031)	(.031)		(.042)	(.026)	
$\Delta log(F)_{jt}$			.045*			.086**			.100**			.064**
			(.027)			(.029)			(.035)			(.031)
$\Delta log(T)_{jt}$		.048*	.006		.061**	-.022		.160**	.088**		.143**	.097**
		(.026)	(.021)		(.032)	(.021)		(.026)	(.030)		(.038)	(.044)
Inputs												
$\Delta log(M)_{it}$	.451**	.451**	.451**	.694**	.688**	.687**	.451**	.440**	.439**	.702**	.606**	.597**
	(.036)	(.036)	(.036)	(.031)	(.030)	(.030)	(.110)	(.038)	(.038)	(.038)	(.040)	(.041)
$\Delta log(K)_{it}$	.111**	.111**	.111**	.099*	.093*	.094**	.110**	.107**	.107**	.083	.092*	.089*
	(.028)	(.028)	(.028)	(.058)	(.058)	(.058)	(.028)	(.028)	(.028)	(.057)	(.052)	(.051)
$\Delta log(L)_{it}$	.227**	.220**	.220**	.213**	.211**	.214**	.229**	.248**	.249**	.194**	.275**	.287**
	(.057)	(.059)	(.060)	(.077)	(.076)	(.076)	(.055)	(.056)	(.057)	(.077)	(.077)	(.031)
N. obs	7,016	7,016	7,016	6,139	6,139	6,139	7,016	7,016	7,016	6,139	6,139	6,139
N. firms	877	877	877	877	877	877	877	877	877	877	877	877
F-test H_0: $\delta_1+\delta_2=0$			3.55**			3.70**			38.95**			16.77**
Corr($\Delta \log F/T , \Delta \log T$)	-.720	-.720	-.720	-.720	-.720	-.720	-.673	-.673	-.673	-.673	-.673	-.673
Hansen J test				5.206	4.846	5.111				8.849*	3.721	3.486

Heteroschedastic robust standard errors are in brackets below estimates. Asterisks indicates significance values (**: $p < 0.05$; *: $p < 0.1$). In GMM-IV inputs are instrumented using two-periods lags of inputs in levels, log(F), log(T) and time trend.

*to avoid log of zeros in sectors were no foreign firm was registered, F/T have been multiplied by 100 and added one.

** Alternative measures of foreign and total sectoral activity: (L): Employment as a measure of foreign and total sectoral activity; (VA): Output (value added) as a measure of foreign and total sectoral activity

Footnotes:

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[1] In particular, the focus on intra-sectoral rather than on inter-sectoral spillovers (Driffield et al., 2002; Smarzynska-Javorcik, 2004) and the disentangling of scale effects from technological externalities (Girma and Gorg, 2002)

[2] For analytical simplicity we chose a Cobb-Douglas specification for the production function. However, as it will be shown shortly, the empirical implementation we use can be derived from a logaritmic differentiation of a generic production function (among others see Caballero and Lyons 1991; Basu and Fernald, 1995).

[3] See Castellani and Zanfei (2003) for a more detailed discussion of the nature and determinants of productivity spillovers in the case of Italy, as opposed to France and Spain.

[4] Studies reviewed by Greenaway and Gorg (2004) and Gorg and Strobl (2001) differ in the type of data used (sector vs. firm-level, panel vs. cross-section), in the vector of control variables, and in the proxies used for aggregate and sectoral activity (employment, capital, output). However there seems to be a general agreement on the use F/T ratio as a measure of externality.

[5] As we noted above, such a simple specification is used for illustrative purposes and is required to keep tractable the analytical derivation of the bias below (Greene, 1997 p. 402).

[6] We thank Jack Lucchetti for an illuminating discussion on this point.

[7] Real values of Y, K and M are obtained by deflating respectively nominal turnover, book value of fixed assets net of depreciation, and costs of materials.

[8] A similar approach is taken by Aitken and Harrison (1999 p.610, footnote 7) and Ruane and Ugur (2002). The former paper reports that spillovers from foreign investments do not change significantly using this specification (negative spillovers to Venezuelan plants are confirmed). However, coefficients estimated with this alternative specification are not reported, thus it is not possible to assess whether the foreign externality eventually increases in magnitude as predicted by our model. The latter paper reports that in a sample of Irish manufacturing firms the coefficient on the foreign presence ratio is non-significantly different from zero, while positive externalities FDI externalities occur if foreign and domestic sectoral employment are entered as separate regressors.