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How much do technological gap, firm size, and regional characteristics matter for the absorptive capacity of Italian enterprises?

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Abstract

The absorptive capacity represents the ability of enterprises to efficiently absorb and internalise knowledge from outside: it represents the link between firms' capabilities to implement new products and the external stock of technological opportunities, such as those spilled-out from Multinational Enterprises (MNEs). In this framework, the present paper aims at testing the absorptive capacity of Italian firms arising from inward Foreign Direct Investment (FDI). Given the peculiar characteristics of the Italian productive system, our analysis will focus on three different dimensions: technology gap between foreign and local enterprises, domestic firm size, and geographical distribution of firms. Our findings suggest that technological gap and firm size matter considerably for the spillover effect. Moreover, spillovers exhibit a sub-national dimension, being present only in North-East region of the Peninsula.

JEL: L33, F23, O17

Keywords: absorptive capacity; MNEs, FDI spillovers; technology gap; firm size; regionality.

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1. Introduction*

The absorptive capacity represents the ability of enterprises to efficiently absorb and internalise knowledge from outside through the adaptation and application of external knowledge sources (Cohen and Levinthal 1989, 1990). In other words, it represents the link between the firms' capabilities to implement new products and the external stock of technological opportunities.

Starting from the seminal works of Cohen and Levinthal, many authors have tried to measure the ability of firms to integrate and exploit external knowledge. In particular, a large strand of literature has focused specifically on the capacity of firms to increase their technological knowledge stock through the adaptation and application of knowledge coming from Multinational Enterprises (MNEs). The recent process of globalisation has in fact led to growing flows of trade across countries, including increasing cross-border interactions among firms arising from Foreign Direct Investment (FDI): when inward FDI-related spillovers happen, local firms can exploit MNEs' knowledge to the degree that it has spilled-out.

Following the main contributions on this topic, the present paper aims at testing the capacity of Italian firms to absorb and internalise knowledge coming from inward FDI-related spillovers from MNEs. The main contribution of our analysis is twofold. First, we present further evidence of the Italian inward spillover effects, by investigating spillovers at both intra-industry and inter-industry level (the latter through the empirical analysis of backward and forward linkages between MNEs and Italian suppliers and customers respectively), whereas empirical evidence for the Italian case remains limited.

Secondly, given the peculiarity of the Italian productive system - characterized by low levels of investment in R&D and innovations in general, by the presence of a large number of micro and small firms, and by the coexistence of different models of production across the Peninsula (alongside the historical dualism between the more advanced North and the less industrialised South) - we test the capacity of Italian firms to absorb external knowledge and technology from MNEs by focusing on three different dimensions, i.e. (i) the level of technology

*Although this work was jointly conceived and produced by the four authors, section 1 was written by Filippo Reganati, sections 2 and 4 by Rosanna Pittiglio, sections 3 and 5 by Edgardo Sica, and section 6 by Cesare Imbriani.

used in local enterprises - that is the technology gap between MNEs and local firms, (ii) the size of domestic firms, and (iii) the geographical distribution of Italian companies.

The reminder of the paper is as follows. Section 2 analyses the channels through which domestic firms may absorb external knowledge from MNEs; section 3 depicts some stylized facts about the Italian economy, stressing the structural characteristics of the local productive system; section 4 discusses the estimation strategy; section 5 presents the empirical results obtained; section 6, finally, concludes.

2. Absorptive capacity and FDI spillovers

The concept of absorptive capacity is founded upon the central idea that some technical knowledge is generally freely available to all firms, in the sense that it can be exploited without paying a fee for its use. In general terms, it is possible to distinguish between two different kinds of absorptive capacity (Arundel et al. 1998). The first type - linked to the process of diffusion or technological transfer across different organisations - concerns skills and expertise required to *adopt* technologies already developed by other firms. The second concerns the ability of firms to *develop* new or improved products and processes by benefiting from discoveries made by other firms or universities. In this framework, it may be of great value to investigate the capacity of firms to adopt and/or develop knowledge and technologies coming specifically from cross-border interactions among enterprises. In particular, it is worth exploring the ability of domestic firms to adapt and/or apply external knowledge and technology spilled-out from MNEs through inward FDI.

In this regard, the literature recognizes at least five *channels* through which spillovers can take place. The first is the so called 'competition effect': the increased competition brought by MNEs' entry may stimulate domestic firms to increase their productivity by updating manufacturing technologies and adopting advanced management practices to meet this competitive challenge[5]. Moreover, the presence of MNEs in domestic markets can provide

[5] The competition effect may also reduce the productivity of domestic firms, since the entry of MNEs can increase the cost of inputs such as labour and raw materials, thus creating a typical crowding-out effect.

domestic firms with an opportunity of 'learning by watching' that indirectly contributes to the rising intensity of domestic R&D. Secondly, spillovers can occur through imitation and demonstration of any activity of foreign technologies (Blomström and Kokko 1998). Through exposure to foreign firms' activities, domestic enterprises can observe these firms' technologies and management practices and imitate them in their own operations, thus increasing their productivity. The third channel happens through domestic linkages both at backward level – i.e. by subcontracting activities between MNEs and local suppliers - and at forward level – i.e. between MNEs and domestic buyers. When MNEs build such backward and forward linkages with domestic suppliers and distributors, knowledge from foreign firms is transmitted to the suppliers and distributors and ultimately to domestic firms using the same suppliers and distributors (Spencer 2008). The fourth channel is workers' mobility and training (that arise from skills of workers, managers, engineers, etc) acquired from foreign firms and then transferred to local plants. Finally, the fifth channel is collaboration activity between foreign and domestic firms, since the eventual involvement of local firms and local universities and/or research institutes in some MNEs' R&D activities may lead to the diffusion of knowledge and technology.

However, the effective capacity of firms to absorb (adapt and/or develop) external knowledge from MNEs may vary according to different dimensions. In particular, the magnitude of inward FDI-related spillovers may be strongly affected by the internal capabilities of local enterprises, above all in terms of level of technology used in domestic firms (i.e. the technology gap between MNEs and local firms), and firm size[6].

The degree of the technology gap between local and foreign firms – i.e. the extent to which foreign firms in an industry are technologically advanced compared to the domestic firms in the same industry – represents an important spillover determinant. Technological gap is relevant to the spillover effect both

[6] It is worth noting that since countries differ along important dimensions such as culture, administrative and institutional context, domestic market, business system, etc, two other possible factors influencing the capacity of local firms to exploit external knowledge are the diversity of FDI country origins and the structural characteristics of the host economy. The first can increase domestic firms' opportunity to learn through exposure to different systems of technologies, management practices and cultural values brought by MNEs; similarly, the structural characteristics of the domestic productive system - in terms, for example, of regional development, sectoral innovation system, etc – may act in favour or against the possibility of MNEs to transfer their technologies.

at horizontal and vertical level. At horizontal level, the extent of spillovers is likely to depend on the technological sophistication of local firms; similarly, at vertical level, the extent of backward (forward) linkages between MNEs and local suppliers (buyers) of intermediate goods is likely to depend upon the stock of technological capabilities of domestic firms in supplying (buying) sectors. It is worth stressing that from both a theoretical and an empirical point of view, it is not obvious what the relation between the level of technology gap – whether small or large - and spillovers should be, since the absorptive capacity literature suggests two opposing arguments. The first argument - proposed originally by Findlay (1978) and confirmed by several works, such as Wang and Blomstrom (1992), Blomstrom and Wolff (1994), and very recently, Jordaan (2008) and Jabbour and Mucchielli (2007) - argues that the potential for positive spillovers is higher when the technology gap between domestic firms and MNEs is large. This assumption is based on the idea that firms with lower stocks of technology have a greater scope for technological accumulation in that they have a larger backlog of established knowledge to assimilate. The second argument is that when the technology gap is too large, the diversity of MNEs may have a weak impact on the productivity of the domestic firms since MNE affiliates may be too advanced to leave any mark on host country's firms. Cantwell (1989), for example, states that a firm's ability to follow and adapt the technological developments of other firms largely depends on its existing technological capability since when the technology gap is large, domestic firms do not have internal knowledge resources to recognize the value and contents of a variety of knowledge elements brought by MNEs, thus making spillovers unlikely to occur. From an empirical point of view, this second argument was initially supported by Kokko (1994), and more recently by Takii (2005), Dimelis (2005), and Hamida and Gugler (2009).

With regard to firm size, it may influence inward FDI-related spillovers insofar as large firms should have a stronger capacity than small ones to recognize, understand, and learn technologies and management practices brought by MNEs, to spread the fixed costs of R&D over a larger sales base, and to exploit economies of scale and scope in R&D activities. Moreover, they possess a larger stock of internal resources and knowledge that can be used as a

complementary asset to the transferred technology from MNEs. In other words, large domestic firms have more internal capabilities that can be used to exploit FDI spillovers (Zhang, Li, and Zhou 2010). On the other hand, SMEs could be hampered in their ability to absorb new technology from MNEs because of a lack of scientific and technical staff or experience.

3. The Italian case: some stylized facts

In order to test the effects of inward FDI-related spillovers from MNEs on the absorptive capacity of domestic firms, we chose the Italian economy as a case-study. The Italian case is relevant for a number of reasons.

First of all, in the last ten years, Italy has received increasing flows of inward FDI, whose value passed from 6,911 million dollars in 1999 to 40,202 million dollars in 2007 (source: ICE 2010). In 2007, the number of foreign-controlled firms amounted at 14,401, with 1,246,794 workers employed. Specifically, the number of foreign firms in the manufacturing sector was 3,301 (with 466,698 workers employed). In particular the sector with the highest percentage of foreign firms was the chemical sector (7.3%), followed by the manufacture of coke and refined petroleum products (5.8%). On the contrary, the sector with the lowest percentage of foreign firms was the manufacture of wood with only 0.1% of foreign presence (ICE 2010). Most importantly, MNEs performed better than their Italian counterparts since they have been more productive, have employed more workers, and are more profitable (ISTAT 2010a). In this framework, it is worth exploring if Italian firms were able to exploit the indirect effects arising from the presence of MNEs in terms of positive externalities.

Secondly, indicators of R&D effort are not favourable to Italy. Expenditure on R&D (in both private and public sector) is slightly above 1% of GDP in 2008, compared with the OECD average of 2.3% (OECD 2009), although under-recording of R&D activity in SMEs, where it is often performed informally, may bias these figures down somewhat. The reasons why R&D activity in Italy is low and why innovation is slow are numerous. In particular, the small size of Italian firms implies the difficulty of meeting the up-front cost of R&D with only limited access to external capital. The last Italian Innovation Survey (ISTAT 2010b) shows that, in 2008, large enterprises were the most innovative enterprises (65.1%),

against SMEs that were innovative at respectively 49.8% and 28.2% of the total. This scarce propensity to innovate, typical of the Italian firms, may suggest the presence of a relevant technological gap between Italian and foreign firms that may affect the capacity of Italian firms to exploit technological spillovers from MNEs.

Thirdly, the Italian productive system is characterised by a large presence of micro and small firms. In 2007, the number of firms with only one employee amounted to 2,593,079 (61.0%), and firms with 2-9 employees were 1,654,102 (38.0%) (ISTAT 2008). On the contrary, large firms (with 250 employees or more) amounted only to 3,630 (less than 1.0%). The huge presence of micro and small firms makes Italy an interesting case for analysing the hypothesis according to which small enterprises are hampered in their ability to absorb new technology from inward FDI-related spillovers because of a lack of scientific and technical staff or experience.

Finally, the Italian economy is historically characterised by a social-economic dualism between the more advanced North and the less industrialised South of the Peninsula. Most of firms are localised in the Centre-North which accounted for 72.0% of total Italian enterprises in 2007 (29.0% in the North-West, 22.0% in the North-East, 21.0% in the centre, and 28.0% in the South) (source: ISTAT 2008). Along with such dualism, the peculiarity of the Italian productive structure is the coexistence of different models of production, such as (i) the 'network enterprise model' in the North-west, where firms – already endowed with higher levels of technological capability than any other areas of Italy – are able to interact efficiently with each other, thus exploiting the positive externalities arising from networking relationships with other enterprises; (ii) the 'industrial district model' in the North-East and in the Centre, characterised by the presence of firms with a self-propelling capacity to achieve efficiency and to be competitive at an international level; and (iii) the 'backward model' of production in the South, characterised by an atavistic lower level of industrialization and by different basic social conditions. In this respect we decide to investigate the existence of spillover effects in the Italian economy by taking into account the geographical distribution of firms (i.e. regionality),

along with the traditional dimensions of domestic firm size and technological gap between local and foreign enterprises.

4. Estimation strategy and data used

Estimating the direct effects of FDI is not an easy task as we lack data on the past ownership of firms to test for the additional effect of foreign entry into the domestic market. Moreover, since foreign firms target larger and are more productive firms, a selection bias arises when one just compares the performance of foreign *versus* domestic firms. Therefore, in this paper, we focus on the indirect effects only.

The traditional approach to analyse productivity consists in estimating a production function and then in using the residuals not explained by the input factors (capital, labor) as a proxy for the Total Factor Productivity (TFP) (Solow residuals). However, as Levinsohn and Petrin (2003) point out, when estimating the production function, one must account for the correlation between input levels and productivity, as profit-maximizing firms respond to increasing productivity by an increased use of factor inputs. Thus, methods that ignore this endogeneity problem - such as OLS or the fixed-effects estimator - inevitably lead to inconsistent estimates of the parameters of the production function. For this reason, in line with the recent literature, we employ the semi-parametric approach suggested by Olley and Pakes (1996), and then modified by Levinsohn and Petrin (2003). This method allows for firm-specific productivity differences that exhibit idiosyncratic changes over time. In principle, the method estimates a traditional Cobb-Douglas production function, taking into account that the error term has two components, of which one is correlated with the choice of inputs by the firm, but is not observable by the econometrician. The authors develop an estimator that uses a free variable such as intermediate inputs (material costs or fuel or electricity) as a proxy for this unobservable productivity shock.

Following this technique, we firstly estimate a log-log transformation of a traditional Cobb-Douglas production function; then, we relate the total factor productivity to the foreign presence variables (horizontal, backward and forward spillovers) and other control variables (the level of competition within

the sector, the economies of scale, and firm fixed effects), thus estimating the following unbalanced panel model of local firms via the fixed-effects estimator (definition of variables used are reported in Table 1):

$$TFP_{it} = \sigma + \theta_1 HERFI_{jt} + \theta_2 MES_{jt} + \theta_3 ES_{jt} + \theta_4 HSPILL_{jt} + \\ + \theta_5 BACKSPILL_{jt} + \theta_6 FORSPILL_{jt} + \theta_7 D_t + \chi_{it} \quad (1)$$

Table 1. Definition of variables used in equation (1)

Variables	Description
TFP	Total Factor Productivity, measured as the difference between the natural logarithm of the value added and the natural logarithm of capital and the natural logarithm of labour, multiplied by their estimated coefficients
σ	Intercept
HERFI	Herfindahl index of turnover, used as a proxy for the level of concentration and thus competition within the sector and year. It is constructed as: $\sum_{i=1}^{N}\left[\frac{sales_{ijt}}{sales_{jt}}\right]^2$ It can be readily deduced that *HERFI* is bound between 0 and 1 and that higher *HERFI* indicates greater market concentration, i.e. less competition.
MES	Minimum efficient scale of the industry, measured as the ratio between firms' sales above the average sales for the industry, divided by total industry sales. It is employed as a proxy for economies of scale (Comanor and Wilson 1967)
ES	Size of the sector (i.e. the external spillovers), measured as (see Castellani and Zanfei, 2007): $\sum_{i=1}^{n} VA_{ijt}$.
HSPILL	Share of foreign firms' output in total sector output. It accounts for the foreign presence in the same sector: $HSPILL_{jt} = \frac{\sum_{i\in j, i=MNEs} OUTPUT_{ijt}}{\sum_{i\in j} OUTPUT_{ijt}}$
*BACKSPILL**	Foreign presence in linked downstream sectors (to which a local company supplies its inputs): $BACKSPILL_{jt} = \sum_{k,k\neq j} \gamma_{jkt} HSPILL_{kt}$ where γ_{jkt} is the proportion of the or *j*'s output supplied to sourcing sectors *k* obtained from the input-output table for domestic intermediate consumption (*i.e.* excluding imports).
*FORSPILL**	Forward vertical spillovers to local firms that buy inputs from foreign firms: $FORSPILL_{jt} = \sum_{l,l\neq j} \delta_{ljt} HSPILL_{lt}$ where δ_{ljt} is the proportion of sector *j*'s inputs purchased from upstream sectors *l*.
D	Dummy time variable employed to control for possible unobserved factors
X	Error term accounting for possible stochastic shocks at a firm level which may affect the dependent variable $\chi_{it} \sim$ IID $(0, \sigma^2)$

The empirical analysis has been conducted by using firm-level data from the AIDA database (*Analisi Informatizzata Delle Aziende*) provided by the Bureau Van Dijk. The AIDA database collects annual accounts of Italian corporate enterprises and contains information on a wide set of economic and financial variables, such as sales, costs and number of employees, value added, fixed tangible assets, R&D, start-up year, as well as the sector of activity and the ownership status. In order to study the spillover effects of foreign firms on domestic firms, we have identified all Italian firms whose Global Ultimate owner is foreign.[7] By omitting all observations for which the necessary data are incomplete, we obtained an unbalanced panel of 1,023,761 observations, over the period 2002-2007. Each variable included in the database was deflated through the price index provided by ISTAT (Italian Institute of Statistics). The advantage of using such a dataset is twofold. Firstly, it is highly representative of the entire universe of corporate companies (e.g., in 2007, our sample covers about 87 percent of total employees declared by the Italian National Institute of Statistics – ISTAT, ASIA, 2008). Secondly, our dataset reflects quite well the actual size distribution of firms in the Italian economy characterized by a large weight of micro and small enterprises. Finally, the Input-Output matrix adopted to determine the possible vertical spillover was provided by ISTAT.

Tables 2 and 3 report some descriptive statistics on our sample: they widely confirm the figures from ICE (2010) and ISTAT (2010a) reported in section 3[8]. In particular, Table 2 contains the mean of the variables for the whole sample distinguished by ownership type as well as tests of comparison of means for the two groups of firms (domestic *versus* foreign firms). All figures presented in the table are averages over the sample period. Focusing our attention on some firm and industry level variables, we observe that multinationals are on average larger, more productive, and more profitable compared to the domestic firms. They also tend to operate in industries that are more concentrated and with a higher minimum efficient scale.

[7] Although the AIDA database offers a flexible definition of ultimate ownership (over 25% or over 50%), in our analysis we consider only a share of 25%. Moreover, as the data were collected year by year, the ownership status variable is time-variant.

[8] Some discrepancies are because our sample is restricted to corporate companies only.

Table 2. Mean statistics by ownership status and t-test of comparison of means for the distributions (domestic *versus* foreign firms) (source: own elaboration based on the AIDA database).

	Definition	Mean		Diff.	t
		Domestic Firms	Foreign Firms		
SIZE	Firm size measured by the number of employees	27.5	216.1	-188	-40.5***
TFP	Total Factor Productivity	9.5	10.4	-0.9	-72.9***
WAGE	Firms' average wage	24925	35056	-10130	-0.2
TECH	R&D intensity as the ratio of R&D expenditures on sales	0.0123	0.0024	0.0098	0.1
Net Profit	Firms' net profit	152991	1732627	-164529	-6.3***
MES	Minimum Efficienty Scale of Industry	0.006	0.015	-0.008	-20.9***
HERF	Herfindhal concentration ratio at industry level	269	456	-186	-20.3***

Note:
*** = statistically significant at 0.01 per cent level.

Table 3 compares the distribution of Italian firms by ownership status, regional location and size (small, medium and large firms), the latter measured by the number of employees[9]. Indeed, according to the figures, domestic firms represent the largest percentage of Italian firms (99.3%), and are mainly of smaller size, while the share of foreign firms is very small (0.7%). It also appears that foreign firms are mainly of large size and are mostly concentrated in the North-West region of Italy (58.4% of the total).

Table 3. Distribution of Italian firms by size, ownership status and regional location (percentages, sample average) (source: own elaboration based on the AIDA database).

	Foreign Firms	Domestic Firms	TOTAL
SIZE_1_49	0.3	99.7	89.9
SIZE _50_249	3.3	96.7	8.8
SIZE _>250	11.5	88.5	1.3
TOTAL	**0.7**	**99.3**	**100.0**
NORTH-WEST	1.2	98.8	34.4
NORTH-EAST	0.6	99.4	28.7
CENTRE	0.4	99.6	19.6
SOUTH	0.2	99.8	17.3
TOTAL	**0.7**	**99.3**	**100.0**

5. Empirical results and interpretations

As shown in Table 2, foreign firms outperform local firms in productivity levels, thus we expect to detect some productivity spillovers in our analysis. Moreover,

[9] Where small firms have 1-49 employees, medium firms 50-249, large firms more than 250 employees.

there might also be some potential for spillovers due to possible complementarities between the technologies of domestic and foreign firms.
Table 4 presents the results of the estimation of equation (1).

Table 4. Estimation of the equation (1).

Dependent variable: TFP		
Regressors	Coefficient	Robust Stand. Err.
Cons	9.523***	0.291
HERFI	-0.012**	0.006
ES	0.001	0.011
HSPILL	0.109	0.070
MES	0.1221869	0.220
Backspill	0.241	0.390
Forspill	0.007**	0.003
Time dummies	Yes	
Adjusted R^2	0.636	
n OBS	562745	

Notes:
Areg estimation was performed to fit a linear regression absorbing one categorical factor.
*** = statistically significant at 0.01 per cent level.
** = statistically significant at 0.05 per cent level.
* = statistically significant at 0.10 per cent level.

Our main findings can be summarized as follows.
First of all, the 'concentration level' - measured by the Herfindahl index - is negative and significant, thus suggesting that less concentrated sectors (i.e. sectors with more competition) benefit more in terms of productivity increases. On the other hand, the 'economies of scale' - measured by the minimum efficient scale - as well as the 'size of sector' are positive and not significant. With regard to the spillover effect, our results suggest, on the one hand, the absence of both horizontal and backward spillovers (being their coefficients positive but not statistically significant), and, on the other, the existence of positive forward spillovers. In other words, our findings highlight that only being a customer of foreign companies has a beneficial effect on local firms' productivity, that is the Italian companies are able to improve themselves once they are offered products and services from MNEs from upstream sectors.
In general terms, such results are in line with most of the recent studies which argue that it is more likely that FDI spillovers would take place through vertical linkages (i.e. backward and/or forward spillovers) as opposed to horizontal ones. This is because MNEs have an incentive to prevent information leakage to their competitors, including local companies, thus reducing the possibility of

horizontal spillovers. By contrast, the existence of forward spillovers is plausible since MNEs in upstream industries may provide inputs to domestic firms that were previously unavailable in the country, or make them technologically more advanced or less expensive, or ensure that they are accompanied by the provision of complementary services (see Smarzynska 2004). Thus, when MNEs involve themselves with domestic companies in downstream sectors, the latter gain technological benefit from the former.

With regards to similar studies applied specifically to the Italian case, they have often produced ambiguous results, probably because they have employed a different dataset, adopted dissimilar econometric methodologies, and explored different periods of time. Our results seem broadly to confirm the lack of horizontal spillovers as in the works of Reganati and Sica (2007) and Imbriani and Reganati (2004) who find evidence of positive but not statistically significant intra-industry spillovers. In the same way, our study confirms the results of Castellani and Zanfei (2007) who find no productivity spillover when multinational presence is specified as a foreign to total activity ratio, although they obtain positive and significant spillovers when controlling for the size of the industry. Similarly, the positive coefficient of backward spillovers confirms the findings of Reganati and Sica (2007), although, in the present study, it becomes not significant.

5.1 Conditional spillovers

After exploring our general findings, Tables 5-7 show the results obtained when the sample is split by certain characteristics in order to detect differences in the pattern of spillovers across different groups of firms (so-called conditional spillovers). In particular, we employ breakdowns by (i) technological gap (Table 5), (ii) firm size (Table 6), and (iii) geographical distribution of enterprises (Table 7).

5.1.1 Technological gap

We define technological gap in terms of the relative productivity performance of domestic companies *vis-à-vis* foreign companies in the same sector. Thus, the technological gap AC_{ij} for a firm *i* is defined in terms of TFP gap, i.e. as the

difference between the productivity of the average foreign firm in the sector and each firm in the sector (see Jabbour and Mucchielli 2007; Flores 2007). It is worth noting that, following the main literature, we use the terms 'productivity gap' and 'technology gap' interchangeably, although the concepts are not exactly the same. Indeed, technology gap can be defined as the difference in the *techniques* available for production, whereas productivity gap represents the difference in *productivity* when the same technology is used (Kathuria 2010). Since determining the technology gap is often tricky, most of the empirical work (including ours) has proxied the 'technology gap' through measures of 'productivity gap': the general idea is that a more productive foreign firm is a reflection of the technological gap between the foreign and the domestic firm.

We check for the sensitivity of the model to alternative ranges of gap by adopting a sub-samples strategy. In other words, we split the sample into three groups according to the absorptive capability. By employing an exogenous grouping model we select some *ad hoc* values from the observations to divide the sample into three sub-samples (low, medium, and high gap). In particular, the group with low *AC* consists of firms with *AC* below the 25th percentile of the *AC* distribution across all domestic firms; the medium *AC* group contains firms with *AC* between the 25th and 75th percentiles, while the high *AC* group includes firms with *AC* above the 75th percentile.

Table 5 presents the results obtained: in particular, we find positive and significant horizontal spillovers, negative and significant backward spillovers, and positive and significant forward spillovers in the group of firms with a low-medium absorptive capacity; on the other hand, we find only negative and significant forward spillovers in the case of high-gap firms, both the horizontal and backward spillovers being positive but not significant.

Table 5. Group estimation according to the technological gap.

Regressors	Dependent variable: TFP		
	High Gap	**Medium Gap**	**Low Gap**
Cons	0.008 (.013)	5.444*** (.517)	11.111*** (.461)
HERFI	0.018 (.13)	0.043*** (.004)	0.054*** (.012)
ES	0.065** (.031)	0.155*** (.020)	-0.040** (.018)
HSPILL	0.193 (.138)	1.537*** (.136)	1.105*** (.159)
MES	0.237 (.292)	-2.326*** (.401)	1.631** (.645)
Backspill	0.304 (.763)	-6.381*** (.699)	-2.326*** (.864)
Forspill	-0.057*** (.008)	0.185*** (.022)	0.0187** (.008)
Time dummies	Yes	Yes	Yes
Adjusted R^2	0.655	0.707	0.770
n OBS	169951	262151	130643

Notes:
Robust standard errors in brackets
Areg estimation was performed to fit a linear regression absorbing one categorical factor.
*** = statistically significant at 0.01 per cent level.
** = statistically significant at 0.05 per cent level.
* = statistically significant at 0.10 per cent level.

In the case of low-medium technological gap, the presence of positive horizontal externalities suggests that domestic firms with at least a basic level of technology are enabled to adapt to better technologies. It is worth noting that this result confirms the findings of Imbriani and Reganati (1999), who find evidence that a small technology gap spurs spillovers from FDI in the Italian case. At the same time, the negative effect of backward linkages with partially-owned affiliates reflects that these firms benefit from their knowledge of the market to diversify their supply network and thus to impose low prices on their suppliers. Finally, the existence of positive forward spillovers (as in the general case) suggests that when the technological gap is low-medium, domestic firms benefit from supplies of intermediate goods and machinery from MNEs, for example since the latter provide better quality products and lower costs that enhance the productivity of Italian firms that use these inputs. Moreover, domestic firms may receive support in the form of training in sales techniques and supply of sales equipment from MNEs, therefore generating more positive externalities.

By contrast, in the case of high gap, the existence of negative forward spillovers suggests that Italian firms in downstream sectors receive a negative externality from MNEs, for example because inputs produced locally by foreign firms can be more expensive and less adapted to local requirements, MNEs being too technologically advanced compared to local enterprises.

All in all, in respect of the general case (Table V), we can conclude that the level of technological gap matters considerably for significance and sign of spillovers in the Italian case.

5.1.2 Firm size

Table 7 presents the results by firm size. Results show that only small-sized companies are able to benefit from forward spillovers, the coefficient being positive and significant, whereas only medium-sized companies benefit from the presence of MNEs in the same productive sector, the coefficient of horizontal spillovers for this category of firms being positive and significant.

Table 6. Group estimation according to the firm size.

Regressors	**Dependent variable: TFP**		
	Small firms	**Medium firms**	**Large Firms**
Cons	8.608*** (.327)	11.809*** (.548)	10.770*** (1.619)
HERFI	-0.014** (.006)	-0.0004 (.0080)	0.0159* (.009)
ES	0.035*** (.013)	-0.067*** (.021)	-0.010 (.064)
HSPILL	0 .047 (.076)	0 .316** (.135)	0.620 (.428)
MES	0.247 (.240)	0.311 (.245)	-0.675 (.522)
Backspill	0.438 (.423)	-0.538 (.776)	-1.184 (2.320)
Forspill	0.008** (.007)	0.004 (.003)	0.010 (.055)
Time dummies	Yes	Yes	Yes
Adjusted R^2	0.6114	0.725	0.801
n OBS	505293	50688	6764

Notes:
Robust standard errors in brackets
Areg estimation was performed to fit a linear regression absorbing one categorical factor.
*** = statistically significant at 0.01 per cent level.
** = statistically significant at 0.05 per cent level.
* = statistically significant at 0.10 per cent level.

The situation for smaller companies echoes the overall results (Table 4) with only positive forward spillovers: this suggests that the existence of a positive forward spillover effect at a national level is based mainly on the smaller Italian firms, these being the only companies that benefit from technology spillovers due to the presence of MNEs in the upstream sectors.

It is worth noting that in case of small firms two opposite effects are generally possible: on the one hand, they have only limited sources for improving their technologies; on the other, they may be more flexible and able to adjust more quickly to a new situation in a market. Our results seem to suggest that smaller firms' flexibility prevails against the effect of their limited sources.

5.1.3 Geographical areas

Finally, Table 7 reports the estimates for productivity spillovers in the Italian manufacturing sector at sub-national level[10].

Table 7. Group estimation according to the geographical area.

Regressors	**Dependent variable: TFP**			
	South	**Centre**	**North-East**	**North-West**
Cons	8.244*** (.863)	8.591*** (.688)	8.854*** (.512)	9.339*** (.427)
HERFI	-0.002 (.010)	-0.004 (.016)	-0186* (.010)	0.0175** (.008)
ES	0.040 (.034)	0.035 (.027)	0.030 (.020)	0.014 (.017)
HSPILL	0.054 (.162)	-0.012 (.160)	0.118 (.139)	0.182* (.107)
MES	-0.038 (.523)	0.010 (.405)	0.268 (.366)	-0.108 (.323)
Backspill	0.744 (1.082)	0.874 (.880)	0.049 (.744)	-0.358 (.601)
Forspill	0.008*(.005)	-0.007 (.010)	0.014*** (.004)	0.036* (.021)
Time dummies	Yes	Yes	Yes	Yes
Adjusted R^2	0.556	0.603	0.652	0.654
n OBS	94851	109105	164255	194534

Notes:
Robust standard errors in brackets
Areg estimation was performed to fit a linear regression absorbing one categorical factor.
*** = statistically significant at 0.01 per cent level.
** = statistically significant at 0.05 per cent level.
* = statistically significant at 0.10 per cent level.

Having a look at the table, we may note the presence of positive and significant forward spillovers from FDI in almost all the Italian sub-regions (specifically in the South, North-East, and North-West), as well as the absolute lack of backward spillovers in any Italian sub-region. Such results reproduce perfectly our overall findings at national level (Table 4), thus meaning that the presence of positive forward linkages between domestic and foreign firms (but also the lack of any backward spillover) does not have a 'geographical' dimension.

However, it is worth observing the presence of a positive and significant horizontal spillover in the North-Western area of Italy, the coefficient being positive and statistically significant at the 5% level. Such a result confirms broadly the findings of Imbriani and Reganati (1999, 2003), whose studies provide evidence for the existence of an intra-sectoral productivity spillover in

[10] The North-Western region comprehends Lombardy, Piemonte, Liguria and Val d'Aosta; the North-Eastern region is composed of Friuli, Trentino, Veneto and Emilia; the Central region is composed of Tuscany, Marche Lazio, Umbria, and finally the Southern area comprehends Abruzzi, Molise, Campania, Calabria, Basilicata, Apulia, Sicily and Sardinia.

the North-Western region of Italy and, at the same time, refute the presence of horizontal spillovers at national level.

Such a result is strongly concerned with the typical structure of the Italian productive system - broadly depicted in section 3 - characterised (beside the well-known economic and social dualism between the North and the South) by an economic and social dualism even within the Northern area, the North-West being more advanced in terms of productive and innovative systems compared to the North-East. Thus in the North-West - characterised by a typical 'network enterprise model' of production - local firms are able to catch through FDI the benefits arising from the spillovers because the foreign presence strengthens the already existing domestic technological capability.

Moreover, the explanation for the lack of spillovers in the North-East, Centre, and South of Italy needs to be differentiated in light of the substantial socio-economic differences of such three areas. The North-Eastern firms – organised mainly in typical 'industrial districts' - are generally SMEs characterised by a self-propelling capacity to achieve efficiency and to be competitive at an international level: the possibility of horizontal spillovers for such firms is consequently weak because of the different model of organisation and production. On the other hand, the lack of horizontal spillovers in the Centre-South is mainly concerned with the different basic conditions (above all in social terms), which make the localisation of investments unattractive both to domestic and foreign capital. Moreover, foreign affiliates - when present - have probably crowded-out the domestic firms, so that there is no company able to absorb the potential spillovers.

6. Conclusions

This paper aims at verifying the absorptive capacity of domestic firms from MNEs through the analysis of inward FDI-related spillovers at both an intra-industry and inter-industry level in the Italian manufacturing sector. In order to take into account the peculiar characteristics of the Italian productive system, we test the absorptive capacity of local firms on the basis of (i) the technological gap between domestic and foreign firms, (ii) the firm size, and (iii) the geographical distribution of the Italian enterprises.

All in all, our findings can be summarized as follows:

- the strongest channel through which Italian firms benefit from the presence of foreign companies is represented by the forward spillovers. Being a customer of foreign companies has a beneficial effect on a firm's productivity: domestic firms seem in fact to benefit from supplies of intermediate goods and machinery from MNEs in the upstream sectors, probably because they provide better quality products at lower costs, as well as providing support to local companies in the form of training in sales techniques and supply of sales equipment;
- the level of technological gap matters considerably for the spillover effect: only the Italian firms with a low-medium technological gap are in fact able to exploit the forward spillover, thus benefiting from the foreign presence;
- similarly, the firm size matters for the spillover since only the small firms seem to take advantage of positive externalities from MNEs in the upstream sectors;
- the forward spillover is not characterised by any sub-national (or local) dimension since it acts in almost all the Italian sub-regions (specifically in the South, North-East, and North-West);
- by contrast, the horizontal spillover exhibits a typical sub-national dimension: it occurs exclusively in the North-West regions of the Peninsula, being instead missing in our results at national level. Such a finding - entirely in line with previous works for the Italian case - is strongly concerned with the typical structure of the Italian productive system, characterised by an economic and social dualism between the North and the South as well as between the North-West and the North-East;
- the horizontal spillover is related to the level of technological gap as well as to the firm size: only medium-sized companies with a low-medium technological gap are in fact able to exploit the positive intra-sectoral externalities from MNEs;
- finally, our findings reveal the lack of any backward spillover for the Italian case, independently from the size of the Italian firms as well as from their geographical localisation. At the same time, low-medium gap firms exhibit a negative effect from backward linkages with partially-owned affiliates,

which probably reflects the fact that MNEs benefit from their knowledge of the market to diversify their supply network and thus to impose low prices on their suppliers.

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