Vertically integrated multinationals and productivity spillovers

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Abstract

How does the activity of foreign affiliates of multinational business group affect the competitiveness of local companies in the host countries? Previous studies have identified the interactions of domestic firms with foreign clients as main mechanism of diffusion of knowledge. However, backward productivity spillovers are not automatic as the organization of multinational production responds to complex strategies that are associated with the decision of undertaking a foreign direct investment. In this paper, we study how these externalities are affected by the strategy of vertical integration of the multinationals. The analysis, based on firm-level data of European manufacturing companies, shows that local firms perceive weaker backward spillovers if client foreign affiliates are vertically integrated in their industry. The spillovers that arise from the activity of companies that do not invest in the domestic firms' industry is 2.6 to 5 times higher than the ones than come from affiliates of multinationals that invest in the industry of local firms.

[PRELIMINARY AND INCOMPLETE]

1 Introduction and objectives

Governments invest in costly policies aimed at attracting foreign direct investments (FDI) in their national territories.[1] These policies are driven by the wide-spread belief that the presence of multinational enterprises (MNEs) may introduce new technologies and commercial practices that can improve the productivity and competitiveness of local companies. The main mechanism of transfer of technology and know-how has been identified to be the collaboration between local suppliers and foreign owned clients. In order to have inputs of high quality that can meet their production needs, foreign affiliates have an incentive to transfer knowledge to local companies that provide them with intermediates. Through these interactions local companies can learn and improve their own efficiency and competitiveness.

The literature on productivity spillovers has grown in the last two decades. Early studies focused exclusively on the effects of the activity of FDIs on the productivity of domestic competitors in the same sector. The empirical evidence on horizontal spillovers is mixed. Blomström and Sjöholm (1999) and Haskel et. al. (2007) find positive intra industry spillovers in Indonesia and in the United Kingdom respectively. Khawar (2003), instead, does not find evidence of spillovers in Mexico, while Aitken (1999) and Konings (2001) find negative spillovers. The main explanation for negative productivity spillovers is identified in *market stealing*: thanks to their competitive advantages, FDI take away market shares from local companies. Unable to exploit economies of scope and of scale, domestic firms suffer from this reduction of demand, as their average production costs increase and their productivity falls.

Javorcik (2004) represents a corner stone in this branch of research. Using Lithuanian data, she shows that the most relevant channel of technological transfer is through backward spillovers: local firms improve their productivity by serving foreign affiliates, whereas the interactions with foreign suppliers and foreign competitors is not as relevant.

Although this mechanism has been broadly recognized as the main channel of knowledge dispersion, backward spillovers are not automatic. Using Romanian data, Javorcik and Spatareanu (2011) show that the geographical distance from the country of origin of the foreign affiliates affect the intensity of backward spillovers perceived by local suppliers. Their results indicate that local firms significantly benefit from interactions with affiliates controlled by MNCs from distant countries (US) while the activity of FDI from close countries (EU) does not affect the domestic firms productivity. The authors interpret this heterogeneity in the intensity of spillovers as evidence of different sourcing strategies of

[1] See Haskel and al (2002)

foreign affiliates. Due to technological requirements, foreign affiliates primarily source from their home countries. Therefore, the likelihood of interactions and the intensity of transfer of knowledge to local companies increase with the trade costs and the distance from the foreign affiliates' home countries. Carluccio and Fally (2013) offer a theoretical contribution to the analysis of backward technological spillovers. The authors argue that the foreign affiliates sourcing decisions and, as a consequence, the intensity of these externalities are determined by the technological compatibility of local suppliers' products and the needs of foreign clients. The collaboration between local firms and foreign affiliates is established only when the suppliers can offer inputs which match the technological standards that FDI require. Therefore, the presence of FDI creates an incentive for local companies to invest in R&D to upgrade their technologies.

The literature on multinational production has shown that business groups' decisions to undertake direct investments abroad respond to complex strategies.
Using a dataset of US multinationals, Yeaple (2003) shows that the location choice of the American FDI is driven by the characteristics of the industries the companies operate in and by the comparative advantages of the host countries.
Alfaro and Charlton (2009) argue that the previous empirical literature misclassified FDI as horizontal investments, because it relied on a loose classification of industries, 2 digit sectors. Using a dataset of US multinationals, the authors show that most of the companies' investments abroad are in fact vertical direct investments: FDI operate in different 4-digit codes than their head-quarters. Using gravity-like equations they show that MNCs own firms in sectors that supply to bulk of intermediate inputs used in the HQ production. These decisions of investment abroad seem to be driven the strategy of vertical integration of the business group along the supply chain. The ownership of their direct suppliers allows the American multinationals to have perfect control over the steps of the production of their final good. This investment strategy suggests a substantial trade of intermediates within the boundaries of the business group and between countries.

In our dataset of European firms we observe that the organization of multinational production seem to rely on similar rationales as the ones outlined in Alfaro and Charlton. Firms affiliated to multinational business groups operate in different 4-digit industries that are close to each other along the supply chain. In each country where the multinationals invest the business groups establish a core business and tend to own firms in the upstream sectors that are producing direct inputs for the production of their core products. From our empirical analysis the investments of multinationals appear to be clustered in two dimensions: multinational business groups own firms that operate in different industries deeply interconnected in the supply chain and that are also located in geographically close

areas. Similarly to Alfaro and Charlton, we interpret this result as suggestive evidence of intra-group sourcing of intermediates.

To have a better understanding of the BGs' organization, we also look at several specific cases of multinational production. An example that well explains our intuition is given by Nestle S.A.

Nestle is a food manufacturer with head quarter located in Switzerland. The Business group controls 851 manufacturing subsidiaries out of Switzerland. 172 of these foreign affiliate are horizontal FDI as they operate in the same 4-digit industry as the parent firm. The vast majority of the affiliates are vertical FDI. Out of the 851 foreign subsidiaries 524 are closely interconnected to the core business of the BG as they produce a large share of intermediates used in the food manufacturing industry.[2]

Along the supply chain, Nestle invests most heavily in the following industries: *Sugar and Confectionery Product Manufacturing* (e.g. Konditerskaya Firma Altai in Austria), the *Dairy Product Manufacturing* (e.g. Nestle Ice Cream Bulgaria AD in Bulgaria), the *Grain and Oilseed Milling* (e.g. Soc Industrial Transformation Produits Agricole in Italy), and the *Bakeries and Tortilla Manufacturing* (e.g. Erlenbacher Backwaren GmbH in Germany). This investment strategy of Nestle S.A seems to reveal a strategy of vertical integration that is based on the direct control of suppliers of intermediates for its core business. (Multinational) Business groups consist of a head-quarter (*DOM/MNE HQ*), affiliates located in the same country (*DOM/MNE LA*) and affiliates located abroad (*FDI*).

We argue that FDI have specific technological endowment that comes from the business group they are affiliated to. Due to needs of technological complementarity and compatibility, FDI mainly rely on other affiliates in their BG as suppliers and will source from other parties only as a second option. As a consequence, the integration choices of the foreign business groups affect the intensity of backward spillovers perceived by local companies.

As this strategy of vertical integration appears to be a common characteristic of multinational investments in Europe and to be driven by the purpose of intra-group sourcing, we expect that the activity of vertically integrated multinationals will be associated with weaker interactions of foreign affiliates with local suppliers. Therefore, the strongest backward productivity spillovers should arise from the presence of FDI of business groups that do not control firms in the same industry of the local companies, whereas the transfer of knowledge to local suppliers should be limited for those foreign affiliates that have to option of buying their inputs from other firms controlled by their BG.

In this paper we empirically test how the intensity of backward productivity spillovers depends on the vertical integration choices of foreign multinationals.

[2] As explained in section 2.2 we use *direct requirement* and *proximity* coefficients to measure the level of interconnections between 4-digit industries.

Our results show that the intensity of spillovers does indeed depend on the strategies of foreign groups making the differences in the impacts of the activity of integrated foreign groups vs non-integrated ones statistically and economically significant.

The remainder of the paper is organized as follows. The next section presents the data we use and our criteria to identify the (multinational) business groups, foreign affiliates and their presence in the host countries. The subsequent section presents a preliminary analysis of firms characteristics and of the BGs' strategies of vertical integration. Next, we offer a detailed explanation of the methodology we implement to estimate firms' productivity. We then present the results of our empirical estimations and our interpretation. The final section concludes and discusses the implications of the new evidence we find.

2 Data

We use a dataset of domestic and foreign owned firms active in Europe in the period 2001-2008. We combine firms' balance-sheet and ownership data from eight (2003-2010) different releases of the Bureau van Dijk's *AMADEUS* database. We restrict our sample to companies that have their main activity in a manufacturing industry according to NACE Revision 1 *and* NAICS 2007 classifications.[3] We retrieve information on the 4-digit NACE and NAICS industries the firm operates in, yearly unconsolidated balance sheet data on revenues, tangible fixed assets, costs of materials, number of employees and total wage bill, and ownership of the company. To identify the industries single firms operate in, we use the information on primary and secondary industry codes.[4]

In order to identify the affiliation of firms, we rely on the information on ultimate owner: this is defined as the entity that directly or indirectly controls at least 50% of the firm's shares. We define as a *business group* (BG) the group of companies that in a given year are ultimately controlled by the same single entity. Affiliates located in a country different from the one of the ultimate owner are defined as *foreign direct investment* (FDI) of the BG. We identify *Multinational Corporations* (MNC) as business groups that have at least one FDI. The use of different releases of the database provides us

[3]Manufacturing industries correspond to sectors 15-36 and sectors 31-33 in NACE Rev. 1 and NAICS 2007 classification, respectively.

[4]The main activity is identified as the 4 digit industry in which the company realizes the largest total value added. Together primary and secondary codes identify all the industries the firm operates in. The bulk of our empirical analysis is based on the NAICS 2007 industry classification. In this paper we refer to NAICS 4-digit codes as *industries* and to NAICS 3-digit codes as *sectors*.

with year-specific information on the ownership and the set of industries each firm operates in.[5] This allows us to trace changes in the ownership structure and identify which industries firms and business groups operate at time-t.

In order to limit the loss of observations due to lack of information on one (or more) production function variables, we interpolate each variable. We deflate sales and materials using the appropriate 2-digit NACE Producer Price Index, while capital is deflated using the an average of the PPI deflators of five sectors that produce the bulk of capital inputs used in manufacturing.[6] We eliminate all observations that report zero or negative values of any of the production variables. To eliminate outliers from our analysis we drop the bottom and top 1% values of production variables ratios and production variables annual growth rates. Finally, we keep only observations with at least two consecutive years as this needed for the production function estimation. This leaves us with an unbalanced panel that consists a total of 1,827,314 firm-year observations, 5% of which refer to multinational business groups. Table 1 reports summary statistics of companies in this dataset.

When we identify the industries the business groups operate in and compute the indexes of FDI horizontal penetration and vertical penetration we try to use the most complete information available. Although information on one or more of the productions variables may be missing, we know that the firm is operating in an industry and we want to account for that. Therefore, we consider all companies in our sample when we map the set of industries in which the groups invest in.[7]

Since the focus of our analysis is on the choices of vertical integration of BGs we define two indexes to measure it. First, we construct a simple dummy VI_{gt} that is $= 1$ if the BGs controls firms in multiple industries. Second, for each industry-j where a BG-g operates we define an index $upVI_{jgt}$ as $\sum_{k \neq j} \gamma_{kj} \mathbb{1}(INV_{kgt} = 1)$ that measures the relevance of other industries in which the BG invests as suppliers of inputs to industry-j.

[5] When either of these variables is missing we assume it did not change from the most recent previous year we have information for.

[6] Like in Javorcik (2004), these sectors are: machinery and equipment; office, accounting and computing machinery and apparatus; motor vehicles, trailers, and semi-trailers; other transport equipment.

[7] This original sample consists of 8,081,191 firm-year observations corresponding to 1,024,847 firms in 83 industries. We define companies that are not ultimately controlled by any entity as *unaffiliated*: these are 925,482. We indentify 37,310 BGs of which 17,382 are MNCs that control 38,654 foreign affiliates. 75% of MNCs invest in 2 or more industries, with an average of 9 industries and a maximum of 53. Clearly, this observation is limited to investments in Europe that we can identify in our dataset. Therefore, extra-European investments (including extra-European head-quarters (HQ)) of MNCs fall out of our sample. Moreover, most of HQ report consolidated data and are excluded from our analysis to avoid double counting.

Table 1: Summary statistics

		Mean	p10	p50	p90	sd
Unaffiliated firms	S_{it}	3735.80	65.90	658.42	6268.48	37243.03
	L_{it}	30.77	2.00	9.00	53.00	232.27
	M_{it}	2049.24	16.00	238.00	3140.00	25145.65
	K_{it}	847.74	5.13	87.00	1389.21	18764.53
	$upVP_{jgt}$	0.00	0.00	0.00	0.01	0.02
	VI_{gt}	0.19	0.00	0.00	1.00	0.39
	# industries	1.41	1.00	1.00	2.00	1.27
	# countries	1.00	1.00	1.00	1.00	0.00
	# firms	1.00	1.00	1.00	1.00	0.00
	FDI	0.00	0.00	0.00	0.00	0.00
Observations				1677928		
Business group	S_{it}	68986.80	931.08	10443.61	114301.38	509432.43
	L_{it}	236.36	8.00	63.00	490.00	1029.50
	M_{it}	42165.91	220.00	4705.00	60749.00	1010804.39
	K_{it}	11794.64	51.44	1394.27	21162.12	65087.44
	$upVI_{jgt}$	0.05	0.00	0.01	0.16	0.08
	VI_{gt}	0.81	0.00	1.00	1.00	0.39
	# industries	7.10	1.00	4.00	18.00	8.76
	# countries	4.27	1.00	2.00	12.00	5.18
	# firms	19.10	2.00	4.00	49.00	41.44
	FDI	0.36	0.00	0.00	1.00	0.48
Observations				149386		
Multinationals	S_{it}	106193.12	2275.32	20531.33	183982.55	743588.45
	L_{it}	314.46	12.00	100.00	681.00	1093.19
	M_{it}	65606.89	681.00	9571.00	97842.00	1345791.09
	K_{it}	17459.31	97.42	2757.54	33645.56	84576.75
	$upVI_{jgt}$	0.08	0.00	0.03	0.22	0.10
	VI_{gt}	0.89	0.00	1.00	1.00	0.32
	# industries	10.12	1.00	6.00	24.00	10.19
	# countries	6.66	2.00	5.00	15.00	5.73
	# firms	30.00	2.00	11.00	78.00	51.61
	FDI	0.70	0.00	1.00	1.00	0.46
Observations				86419		

2.1 Analysis of the vertical integration and the geographical dispersion of multinational production

In this section, we present our analysis of multinational production through which we aim to identify common rationales that determine the MNCs' decision of investment abroad and their organization strategies. Previous research has analysed how the characteristics of firms' industries, comparative advantages of countries, and their complementarity affect the location choices of FDI (e.g. Yeaple 2003). In this study we focus on the intensity of interconnections between the industries in which BGs invest. The classical theory on firms' boundaries would predict the existence of trade in intermediates between affiliates of a vertically integrated BG. The sourcing strategy of the single affiliates depend on the *make or buy* decisions of the group they belong to. As we argued in section 1, single affiliates are endowed with a group-specific technology that makes the products of other affiliates in their group the best match for their needs in terms of technological standards of their inputs. Furthermore, the transaction costs are lower for companies in the same BGs than for unrelated parties. Therefore, firms controlled by MNCs should primarily purchase their inputs within the boundaries of the group.
As we do not have information on transactions, we cannot study this issue directly. However, we exploit the information on the industries in which companies operate and on their geographical location.
If vertical integration is an important driver of the MNCs' decisions to investment abroad, we should find that multinationals invest in industries that intensely trade in intermediates and control affiliates that are geographically clustered, as the shipment costs increase with geographical distance.

In line with Alfaro and Charlton (2009) and Antras et al (2012), we measure the intensity of industries' integration in the supply chain using two indexes. These are *direct requirement* (dr_{ij}) and *proximity* ($proximity_{ij}$) which are based on the coefficients of inter-industry trade in goods between each pair of industries i and j.[8] The higher their values the more interdependent the two industries are in the supply chain.
Direct requirement is the value of inputs from industry-j that industry-i needs to produce one dollar of output. This first index measures how important the products of industry-j are as inputs in industry-i's production. The index *proximity* is constructed as the share of output of industry-j directly purchased by industry-i over its total use of industry-j's products. It measures how much of industry-j's output is directly used as inputs by industry-i, instead of as a component embodied in other inputs. Similarly to *direct requirement*, the higher its value the more interdependent the two industries are in

[8]The I/O Table is provided by the Bureau of Economics Activity, we use the 2007 issue. The coefficients of direct requirement are available on BEA's website, while we had to calculate proximity indexes as in Alfaro and Charlton (2009). The BEA Tables are designed at 6-digit code level, we reduce the level of detail to 4-digit.

the supply chain.

Besides the input/output relationships between the industries of the affiliates we also look at their geographical location. We use the measures of geographical distance computed in Head et al (2010).[9]

In order to test whether the investment organization of MNCs suggest intra-group sourcing, we answer the following questions: Do MNCs tend to be vertically integrated? If, so do they own firms in industries that supply inputs to their core business? Do MNCs own firms in close locations?

We estimate the following OLS models:

$$D(INV_{n0n1c0c1}) = \alpha_1 geod_{C0C1} + \alpha_2 dr_{01} + \alpha_3 dr_{10} + \alpha_4 geod{*}dr_{01} + \alpha_5 geod{*}dr_{10} + \delta_{C0} + \delta_{C1} + \delta_{n0} + \delta_{n1} + \epsilon_{n0n1c0c1} \quad (1)$$

and

$$ln(Nf_{n0n1c0c1}) = \beta_1 geod_{C0C1} + \beta_2 dr_{01} + \beta_{23} dr_{10} + \beta_4 geod{*}dr_{01} + \beta_5 geod{*}dr_{10} + \delta_{C0} + \delta_{C1} + \delta_{n0} + \delta_{n1} + \upsilon_{n0n1c0c1} \quad (2)$$

For each company we have information on its main industry n0, the country where it is located c0. We restrict our estimations to one single year (2006) and aggregate all firm-level observation at country-industry level. We match each country-industry pair $\{n0, c0\}$ with all possible country-industry $\{n1, c1\}$ pairs. Our sample consists of 33x33 countries and 78x78 possible industry pairs, for a total of 7,239,960 combinations or quartets {n0,c0,n1,c1}. [10]

D($INV_{n0n1c0c1}$) in equation (1) is a dummy that takes value = 1 if we observe at least one MNC that controls firms in $\{n0, c0\}$ and in $\{n1, c1\}$. The variable dr_{xz} is the direct requirement of goods from the affiliate-x's industry for production of the affiliate-z's industry. The variable $geod_{C0C1}$ is the log of geographical distances between the countries $c0$ and $c1$. In order to control for features of industries and for the characteristics of countries that could affect the decision of FDI location, we include a set of industries and country dummies $(\delta_{n0}, \delta_{C0}, \delta_{n1}, \delta_{C1})$.

For the sake of presentation, we limit the discussion to the estimation of model (1): estimated coefficient in model (2) are consistent and point to a similar evidence.

The coefficients $\alpha_1, \alpha_2, \alpha_3$ in the first and second columns are highly significant and show that MNCs are likely to invest in close locations and in industries that are highly interconnected. Similar to the

[9]Specifically, we use the measures of pairwise geographical distances between the capital cities of the countries and the same measures weighted by population densities within each country. These data are provided by CEPII.

[10]To avoid double counting, we keep in $\{n0, c0\}$ only core business of their MNCs, while we keep all investments when we pair the observations with all possible $\{n1, c1\}$ combinations. In only 72,475 quartets we observe investments, 92.2% of which involve multinational production. We exclude from the analysis same industry investments ($z = x$, 16,695 observations), while we keep pairs of investments in the same country ($c0 = c1$, 5,652 observations).

results of Alfaro and Charlton (2009), MNCs tend to own firms in supplier and client industries of the one in which they set their core business.

The signs of the interactions terms between the indexes of interconnections and geographic distances provide a new result in the research on multinational production. The coefficients are negative and highly significant. The more interdependent are the industries in which MNCs invest, the closer the affiliates are located. We interpret these results as suggestive evidence of vertical integration and intra-group trade of intermediate goods.[11]

Table 2 and Table 3 display the results of the estimation of model (1) and of model (2), respectively.

[11] We also replace direct requirement indexes with proximities: the results remain virtually unchanged.

Table 2: Investments

Variable	$INV_{n0n1c0c1}$	$INV_{n0n1c0c1}$	$INV_{n0n1c0c1}$	$INV_{n0n1c0c1}$	$INV_{n0n1c0c1}$
$geod_{C0C1}$	-0.007***	-0.007***	-0.007***	-0.007***	-0.004***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
dr_{01}		0.125***		0.596***	
		(0.016)		(0.128)	
dr_{10}		0.124***		0.530***	
		(0.013)		(0.078)	
$proximity_{01}$			0.019***		0.090***
			(0.001)		(0.007)
$proximity_{10}$			0.020***		0.101***
			(0.001)		(0.005)
$geod * dr_{01}$				-0.067***	
				(0.017)	
$geod * dr_{10}$				-0.058***	
				(0.010)	
$geod * prox_{01}$					-0.010***
					(0.001)
$geod * prox_{10}$					-0.012***
					(0.001)
δ_{C0}	YES	YES	YES	YES	YES
δ_{C1}	YES	YES	YES	YES	YES
δ_{n0}	YES	YES	YES	YES	YES
δ_{n1}	YES	YES	YES	YES	YES
N.Obs	7239960	7239960	7239960	7239960	7239960
R2	.027	.029	.031	.029	.032

,,*** Statistically significant at 10, 5, 1%, respectively.

Robust standard errors clustered by $\{n0, c0\}$ pairs

Table 3: # Firms

Variable	$ln(Nf)$	$ln(Nf)$	$ln(Nf)$	$ln(Nf)$	$ln(Nf)$
$geod_{C0C1}$	-0.098***	-0.099***	-0.099***	-0.092***	-0.067***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
dr_{01}		1.607***		3.709***	
		(0.131)		(1.038)	
dr_{10}		1.686***		3.039***	
		(0.095)		(0.642)	
$proximity_{01}$			0.206***		0.518***
			(0.015)		(0.106)
$proximity_{10}$			0.181***		0.488***
			(0.013)		(0.074)
$geod * dr_{01}$				-0.310**	
				(0.146)	
$geod * dr_{10}$				-0.199**	
				(0.090)	
$geod * prox_{01}$					-0.047***
					(0.015)
$geod * prox_{10}$					-0.046***
					(0.010)
δ_{C0}	YES	YES	YES	YES	YES
δ_{C1}	YES	YES	YES	YES	YES
δ_{n0}	YES	YES	YES	YES	YES
δ_{n1}	YES	YES	YES	YES	YES
N.Obs	72475	72475	72475	72475	72475
R2	.17	.19	.19	.19	.19

,,*** Statistically significant at 10, 5, 1%, respectively.

Robust standard errors clustered by $\{n0, c0\}$ pairs

2.2 Analysis of firms' characteristics

As it appears from the summary statistics in Table 2 companies affiliated to business groups are much larger than unaffiliated ones in every dimension.

They are bigger in terms of size (no. employees L_{it} and sales S_{it}) and capital intensity. Both local and multinational business groups invest in several industries, but on average multinationals control more affiliates and invests in more industries than local business groups. The index of upstream vertical integration ($upVI_{jgt}$) is also higher for MNCs' affiliates than for firms that belong to local business

groups. This statistic suggests that the average affiliates of MNCs is more likely to belong to a business group that owns companies in its supplying sectors than a firm controlled by a BG that invests only in the domestic market.

To test whether these differences are statistically and economically significant we estimate a set of OLS regressions based on the model of Bernard and Jensen (1999):

$$lnY_{it} = \beta_0 + \beta_1 DOM\ HQ_{it} + \beta_2 DOM\ LA_{it} + \beta_3 MNE\ HQ_{it} + \beta_5 HQ\ LA_{it} + \beta_6 FDI_{it} + \beta_2 l_{it} + \beta_X X_{it} + \delta_{nyc} + \epsilon_{it} \quad (3)$$

where Y_{it} is the variable of interest for firm i active in industry-n, country-c in a given year-y. The vector Y_{it} consists of number of employees L_{it}, value of sales S_{it}, expenditure in intermediate goods M_{it}, capital K_{it} and total wage bill W_{it}.

As all the dependent variables are expressed in natural logarithms, the βs measure the premia associated to each status of firms in percentage terms compared to unaffiliated firms in the same country, industry and year.

Table 4: Estimation results : Companies status

Variable	$\ln L_{it}$	$\ln S_{it}$	$\ln M_{it}$	$\ln K_{it}$	$\ln W_{it}$
DOM HQ	1.682***	2.109***	2.228***	2.289***	0.219***
	(0.024)	(0.028)	(0.031)	(0.033)	(0.007)
DOM LA	1.173***	1.422***	1.526***	1.445***	0.136***
	(0.009)	(0.011)	(0.012)	(0.013)	(0.003)
MNE HQ	2.341***	2.710***	2.860***	2.964***	0.215***
	(0.064)	(0.067)	(0.072)	(0.083)	(0.013)
MNE LA	2.095***	2.575***	2.755***	2.728***	0.211***
	(0.024)	(0.026)	(0.029)	(0.032)	(0.006)
FDI	2.008***	2.590***	2.752***	2.661***	0.353***
	(0.015)	(0.017)	(0.019)	(0.022)	(0.004)
l_{it}	NO	YES	YES	YES	YES
δ_{nyc}	YES	YES	YES	YES	YES
N.Obs	1754204	1754204	1754204	1754204	1743784
R2	.3	.46	.41	.31	.86

,,*** Statistically significant at 10, 5, 1%, respectively.

s.e. clustered by ID

As expected, firms that are affiliated to BGs are larger than *unaffiliated* companies in every di-

mension. Furthermore, firms that belong to MNCs have higher premia than local BGs.

We also exploit the within-group heterogeneity of affiliates and test how the performance of single companies relate to the relative importance of their business for the BG. We identify as *core business* the industry that has the highest value of sales within the BG in a country-c at time-t.[12] We test how the different characteristics of single affiliates depend on the distance of industry-j from the *core* business for group-g in the country. As main regressor we use the dummy $CORE_{ijgt}$ which is equal 1 if the company is operating in the core business of the company-i and 0 otherwise. Furthermore we use a measure of distance from the core business, the (log of the) rank of industry-j in terms of relative importance for the group-g in country-c. [13]

$$ln(Y)_{it} = \beta_0 + \beta_1 CORE_{jgt} + \beta_2 l_{it} + \delta_{gct} + \epsilon_{it} \tag{4}$$

Table 5: Within Group Performances

Variable	lnL_{it}	lnS_{it}	lnM_{it}	lnK_{it}	lnW_{it}	ln$(S/L)_{it}$	ln$(S/L)_{it}$
$CORE_{ijgt}$	0.987***	0.352***	0.479***	0.202***	0.067***	0.303***	
	(0.052)	(0.030)	(0.046)	(0.051)	(0.017)	(0.027)	
$lnRank_{ijgt}$							-0.316***
							(0.032)
l_{it}	NO	YES	YES	YES	YES	YES	YES
δ_{gt}	YES	YES	YES	YES	YES	YES	YES
N.obs.	403572	403572	403572	403572	401069	403572	403572
R2	.94	.99	.98	.98	.99	.98	.98

,,*** Statistically significant at 10, 5, 1%, respectively.

The affiliates operating in the *core business* are larger, consume more intermediate inputs and are more capital intense than others. Furthermore affiliates operating in the *core business* are also much more productive. The differences in labour productivity are indeed statistically and economically significant: firms in the second and third most relevant industries are on average respectively 22% and 35% less productive than the affiliates in the core industry.

Given the results presented in section 2.1, MNCs seem to be vertically integrated and to invest in close locations. Now, we test whether the intensity of vertical integration is higher for MNCs' affiliates than for local BGs and we analyse how it is associated to the firms' characteristics.

[12] This means that the same BG has a core business in each country it invests in.

[13] The index $Rank_{ijgt}$ is based on the value of total sales, $Rank_{ijgt}$ =1 for core business, = 2 for the second most important industry, =3 for the third and so on. For the sake of results' presentation, we report only the effect of $lnRank_{ijgt}$ on firm's labour productivity. All other results are consistent with those displayed in Table 5

To do so, we limit our analysis to affiliated companies. To measure the intensity of upstream vertical integration we use as dependent variable the index $upVI_{jgt}$ presented in section 2. Secondly, to measure how this index correlates with the characteristics of the affiliates, we include it in the RHS of the regressions .

$$upVI_{jgt} = \beta_0 + \beta_1 MNE_{it} + \beta_2 l_{it} + \beta_s No.industries_{gt} + \delta_{nyc} + \epsilon_{it} \quad (5)$$

$$lnY_{it} = \beta_0 + \beta_1 MNE_{it} + \beta_2 upVI_{jgt} + \beta_3 upVI_{jgt} * MNE_{it} + \beta_4 l_{it} + \beta_s No.industries_{gt} + \delta_{nyc} + \epsilon_{it} \quad (6)$$

Table 6 displays the results of these regressions. Again, in order to make the indexes of upstream vertical integration comparable across industries, we include the country-industry-year triplet dummies. From the first model (column 1) we can see that the intensity of vertical integration is on average higher in MNC than in local business groups' affiliates.

Interestingly, the $upVI_{jgt}$ is positively correlated with the sales of the affiliates. Even more important, the higher the intensity of interconnections with the upstream sectors in which their BG invests, the larger is the firms' consumption of intermediates. Therefore, the companies' demand of intermediate inputs depends on the vertical integration choices of the BG.

In the light of these results and of the facts presented in section 2.1, the BGs decisions of investing in different sectors appear to be due to strategic choices of vertical integration. In order to have control on the stages of their production, BGs invest in multiple sectors closely related to each other within the supply chain so that their affiliates can purchase their inputs within the group. This evidence is even stronger for multinationals. Due to the lack of transaction data we cannot directly test whether these affiliates trade with each other, but we see these results as suggestive evidence of internal sourcing.

Table 6: Business groups: upstream vertical integration

Variable	$upVI_{it}$	$\ln L_{it}$	$\ln S_{it}$	$\ln M_{it}$	$\ln K_{it}$	$\ln W_{it}$
MNE_{it}	0.014***	0.818***	0.252***	0.292***	0.172***	0.170***
	(0.001)	(0.020)	(0.010)	(0.015)	(0.016)	(0.005)
$upVI_{jgt}$		1.610***	0.072	0.556***	0.907***	0.094
		(0.246)	(0.137)	(0.193)	(0.205)	(0.062)
MNE_{it}*$upVI_{jgt}$		-1.533***	0.460***	0.388*	0.007	-0.074
		(0.268)	(0.144)	(0.206)	(0.218)	(0.068)
l_{it}	YES	NO	YES	YES	YES	YES
# industries	YES	YES	YES	YES	YES	YES
δ_{nyc}	YES	YES	YES	YES	YES	YES
N.Obs	135756	135756	135756	135756	135756	135217
R2	.44	.29	.87	.77	.75	.83

,,*** Statistically significant at 10, 5, 1%, respectively.

s.e. clustered by ID

2.3 FDI horizontal and vertical penetration indexes

We measure the presence of FDI in an industry-j at time-t in country-c as the share of sales of foreign affiliates'.[14] The Horizontal Penetration (HP_{ijct}, henceforth) is constructed as,

$$HP_{ijct} = \frac{\sum_{f=1,\neq i \text{ in } jct}^{N} SALES_{ft} * FDI_{ft}}{\sum_{f=1 \text{ in } jt}^{N} SALES_{ft}} \tag{7}$$

Where FDI_{ft} is a dummy indicating whether the firm-f is a foreign affiliate at time t.

Clearly, this indicator of foreign presence changes over time and across industries, but is by definition identical for all the domestic firms active in the same industry in year-t.

In order to estimate the effect of foreign affiliates on the productivity of local suppliers, we will relate the estimated *tfp* of domestic companies to the presence of FDI in downstream industries. When we calculate these vertical penetration indexes we correct the measures for the vertical integration of the business groups. More precisely, we take into account whether the foreign affiliates in client industries belong to business groups that control any firm in the industry of the local firms.

Thus, for a each industry-j we compute two indexes of downstream vertical penetration: the first (VP_{jct}^{-j}) represents the total presence in client sectors of foreign multinationals that are not investing in the industry-j; the second (VP_{jct}^{j}), instead, measures the presence of foreign affiliates that belong to a business group-g that also owns a firm industry-j.

[14] Practically we measure this index by country, year and 4-digit NAICS industry.

The index VP^{-j}_{jct} is constructed as follows:

$$VP^{j}_{jct} = \sum_{k=1,\neq j \text{ in } ct}^{N} \alpha_{jk} HP^{j}_{kct} \tag{8}$$

where HP^{j}_{kct} is defined as

$$HP^{j}_{kct} = \frac{\sum_{f=1 \text{ in } kct}^{N} SALES_{ft} * FDI_{ft} * \mathbb{1}(INV_{gjt}=1)}{\sum_{f=1 \text{ in } kjt}^{N} SALES_{ft}}$$

INV_{gjt} is a dummy that takes value 1 if the business group-g controls an affiliate in industry-j.[15] Similarly, the index VP^{-j}_{jct} is constructed as:

$$VP^{-j}_{jct} = \sum_{k=1,\neq j \text{ in } ct}^{N} \alpha_{jk} HP^{-j}_{kct} \tag{9}$$

where HP^{-j}_{kct} is defined as:

$$HP^{-j}_{kct} = \frac{\sum_{f=1 \text{ in } kct}^{N} SALES_{ft} * FDI_{ft} * \mathbb{1}(INV_{gjt}=0)}{\sum_{f=1 \text{ in } kjt}^{N} SALES_{ft}}$$

The coefficients α_{jk} are used to weight the HP_{kct} for their relative importance for industry-j. These coefficients are defined as the ratio of flows of industry-j's output supplied to industry-k over total sales of industry-j used as intermediate inputs in the manufacturing sector.[16]

Table 7: FDI Indexes

	Mean	p10	p50	p90	sd
HP_{jct}	0.16	0.01	0.10	0.39	0.17
VP_{jct}	0.07	0.00	0.05	0.16	0.07
VP^{-j}_{jct}	0.04	0.00	0.03	0.11	0.05
VP^{j}_{jct}	0.02	0.00	0.01	0.07	0.03
Observations			1888610		

[15] When we construct this index, we consider all BG's investments, regardless of their location. This means that the BG might control a firm in industry-j in a different country.

[16] These coefficients are derived from the US Input/Output-Tables 2007. Since inter-industry relationships may be different across countries and may change over time, it would be ideal to use country-year specific tables. Unfortunately, IO tables at this level of disaggregation are available only for the USA. The reader should bear in mind this caveat in interpreting our results.

3 Estimation

3.1 Total Factor Productivity

This section describes our strategy to estimate the production function parameters and firms' productivity.

Consider the following log transformation of a generic gross-output production function,

$$q_{it} = f(m_{it}, l_{it}, k_{it}) + \omega_{it} + \epsilon_{it} \tag{10}$$

The lower cases represent the natural logarithms of the production variables. Thus, q_{it} is the log of gross output, l_{it} log of labour, m_{it} the log of intermediate inputs, k_{it} is the log of capital, ω_{it} is the productivity shock observed by the firm but not by the researcher, finally ϵ_{it} represents the measurement error and idiosyncratic unexpected productivity shock, unobserved by both the econometrician and the company. Once we identify the production coefficients we can retrieve the estimated productivity as residual.[17]

Arguably, the production function of multinational firms and local companies may be very different. Using a sample of local companies and MNCs' affiliates would imply the assumption that the two types of firms share a common production function: this would lead to the estimation of biased production function coefficients of local companies and, as a consequence, of their productivity. Thus, we estimate the production function separately for each country-sector pair excluding the multinational firms from the sample.

To control for endogeneity of input usage in estimating the inputs' coefficients of the production function, we closely follow the two-step procedure developed in [1] (hereafter ACF).

We assume that productivity evolves over time as a Markov process with endogenous law of motion. The evolution of productivity depends on the characteristics of firm-i's business group-g, such as vertical integration (VI_{gt}) and number of affiliates (Nf_{gt}), the relative importance of industry-j for the group ($rank_{jgt}$), and on the activity of foreign affiliates in industry-j (HP_{jt}) and downstream sectors (VP_{jt}).[18] In other words, we define the law of motion of productivity as follows:

$$\omega_{it} = g(\omega_{it-1}, VI_{gt-1}, rank_{jgt-1}, Nf_{gt-1}, HP_{jt-1}, VP_{jt-1}) + \xi_{it} \tag{11}$$

[17] Since we do not observe quantities and prices of the output and inputs used by the firm, we have to rely on deflated sales and input costs to proxy the physical output and inputs. [12] and De Loecker (2011) argue that the use of industry-wide indexes might create a bias in our production function estimations. The reader should bear these considerations in mind in interpreting our results.

[18] [14] discusses the importance of including in the productivity's law of motion relevant elements that could affect the firm's efficiency.

The characteristics of firm-i's business group and the measured presences of FDI are included in the law of motion to account for the fact that these elements *may* affect productivity.[19] Indeed, the affiliation of firms to a business group is likely associated with specific business strategies and transfer of technologies that may affect and improve the productivity of the single affiliates. In line with the results of previous research on productivity spillovers, the activity of FDI can induce changes in the productivity of local firms. In this specification these variables are allowed to impact productivity, but this does not mean that they will necessarily have an effect.

In the first step of the ACF procedure, we estimate $\hat{\phi}_{it}$ and $\hat{\epsilon}_{it}$ in

$$q_{it} = \phi_{it} + \epsilon_{it} \tag{12}$$

where $\phi_{it} = f_{it}(m_{it}, l_{it}, k_{it}) + h(m_{it}, l_{it}, k_{it}, z_{it}, \delta_t)$, with h(.) representing the inverse material demand function that we use to proxy the unobserved productivity term.

We collect in z_{it} all the elements - other than expenditures in input variables - that affect firm-i demand for materials: these are $\{HP_{jt}, VP_{jt}, upVI_{jgt}, rank_{jgt}, BG_{gt}\}$.

In section 2.2 we have shown that the firms' consumption of intermediates varies with the level of upstream vertical integration in their industry of the business group their are affiliated to and depends on the relative importance of their line of business for the group. Due to reasons of technological complementarity and specific inputs needs, companies affiliated to a vertically integrated business group are more likely to source intermediate inputs from other affiliates of the business group. Finally, the activity of foreign affiliates may modify the productivity of local firms and their demand of materials through competition pressure and technological spillovers.

The estimate of the polynomial expansion ϕ_{it} measures the output net of the unexpected output shock and measurement error ϵ_{it} in Eq. (12).

To recover the innovation shock $\xi_{it}(\beta)$, we define productivity $\omega_{it}(\beta)$ as $\hat{\phi}_{it} - f_{it}(X_{it}, \beta)$ and we non-parametrically regress it on the third order polynomial of its lag and the first lags of the other elements included in the productivity law of motion.

In the second step, the production function coefficients are estimated through GMM, using as valid instruments the inputs orthogonal to the unexpected productivity shock.

The moments that identify the production parameters are:

$$E[\xi_{it}(\beta) I_{it}] = 0 \tag{13}$$

[19] In this section, we include the total VP_{jct} defined as $\sum_{k=1,\neq j \text{ in } ct}^{N} \alpha_{jk} HP_{kct}$, without distinguishing by the investment decisions of multinational business groups

where $I'_{it} \equiv (l_{it-1}, m_{it-1}, k_{it}, l^2_{it-1}, m^2_{it-1}, k^2_{it}, l_{it-1}m_{it-1}, l_{it-1}, k_{it}, m_{t-1}k_{it}, l_{it-1}m_{it-1}k_{it})$ is the vector of instruments. In the Cobb-Douglas specification this system becomes computationally much simpler as the vector of parameters β is reduced to $\beta = (\beta_l, \beta_m, \beta_k)$ and $I'_{it} = (l_{it-1}, m_{it-1}, k_{it})$. These instruments are all orthogonal to the unexpected innovation component of the productivity as they all were decided before the productivity shock is realized. We can now estimate the revenue-based total factor productivity $\varphi_{it} = \hat{\phi}_{it} - f(X_{it}, \hat{\beta})$.

4 Results

In this section, we present our strategy to test whether the choices of vertical integration of business groups affect the backward productivity spillovers perceived by local suppliers.

As a first step, we estimate the existence and intensity of horizontal and backward spillovers without making any distinction between vertically integrated and non-vertically integrated MNCs. This exercise is primarily aimed at testing whether, overall, local companies benefit from the activity of FDI in client sectors. We estimate the following fixed effect model under the assumption of Cobb-Douglas and Translog production function separately:

$$tfp_{ijct} = \alpha_i + \alpha_1 HP_{jct-1} + \alpha_2 VP_{jct-1} + \alpha_X X_{it} + \delta_{syc} + \epsilon_{it} \tag{14}$$

Besides the index HP_{jt-1} that measures the presence of foreign competitors, we control for a set of other variables (X_{it}) that may influence the productivity of the company These are the log of firm's capital intensity and its age, the Herfindhal index HHI_{jct} and time, sector and country dummies δ_{syc}. These controls limit concerns about a potential bias in the estimated effects of FDI activity, due to the endogeneity of foreign investments. The use of the set of dummies δ_{syc} controls for differences and trends in profitability across sectors and over time. Finally, we cluster the error terms at year-industry-country level, as this is the dimension at which HP_{jct} and VP_{jct} varies ([15]).

The coefficient α_2 measures the net impact of the activity of FDI in client industries on the productivity of local companies. The coefficient is positive and highly significant indicating that domestic firms productivity increases with the presence of foreign affiliates in client industries. The results of the regressions are reported in the first to sixth columns of Table 8.

As presented in section 2.3 we construct two indexes of FDI presence in client industries VP^j_{jct} and VP^{-j}_{jct} that account for the strategy of vertical integration of MNCs. We use these indexes as main regressors in the following fixed effect model and estimate their impact on the productivity of domestic firms.

$$tfp_{ijct} = \alpha_i + \beta_1 HP_{jct-1} + \beta_2 VP^j_{jct-1} + \beta_3 VP^{-j}_{jct-1} + \beta_X X_{it} + \delta_{syc} + \upsilon_{it} \tag{15}$$

The coefficient β_2 measures the backward productivity spillovers that come from the activity of affiliates of MNCs which are not investing in industry-j, while β_3 measures the effect of the presence of FDI in client sectors that belong to BGs that control firms in industry-j.

In order to formally test whether the likelihood of cooperation with local companies and the intensity of spillover are different for the two groups, we perform a F-test of equality of the two estimated coefficients. Table 8 displays our results. We first include the two indexes separately (second and third columns in each specification) and then together (fourth and firth columns). In these latter we can perform the test of equality. We refer to the model with the set of triplet dummies as our favourite.

The results we obtain are consistent and point at a similar evidence. We find that the expansion in downstream sectors of foreign affiliates of either type is beneficial for local companies. However, the F-test always reject the hypothesis of equality of coefficients, the spillovers are stronger from affiliates of MNCs that do not invest in industry-j. The difference is statistically and economically significant: the increase in firms' productivity associated to one standard deviation increase in VP^{-j}_{jct-1} is 2.6 to 5 times larger than the growth in tfp due to a one standard deviation increase in VP^{j}_{jct-1}.

Table 8: Productivity spillovers

F($\mathbf{X}$, β)	Cobb-Douglas					Translog				
Variable	tfp_{it}	tfp_{it}	tfp_{it}	tfp_{it}	tfp_{it}	tfp_{it}	tfp_{it}	tfp_{it}	tfp_{it}	tfp_{it}
HP_{jct-1}	0.025***	0.027***	0.027***	0.027***	0.018***	0.015**	0.017**	0.017***	0.017***	0.015**
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.006)
VP_{jct-1}	0.162***					0.146***				
	(0.030)					(0.027)				
VP^{j}_{jct-1}		-0.013		0.045	0.059*		-0.019		0.034	0.086***
		(0.042)		(0.042)	(0.035)		(0.039)		(0.040)	(0.029)
VP^{-j}_{jct-1}			0.195***	0.202***	0.182***			0.178***	0.183***	0.142***
			(0.031)	(0.032)	(0.025)			(0.029)	(0.030)	(0.021)
δ_t	YES	YES	YES	YES	NO	YES	YES	YES	YES	NO
δ_{ct}	YES	YES	YES	YES	NO	YES	YES	YES	YES	NO
δ_{st}	YES	YES	YES	YES	NO	YES	YES	YES	YES	NO
δ_{syc}	NO	NO	NO	NO	YES	NO	NO	NO	NO	YES
N.obs.	1037555	1037555	1037555	1037555	1037555	1037555	1037555	1037555	1037555	1037555
R2	.33	.33	.33	.33	.4	.65	.65	.65	.65	.79
$VP^{j}_{jct-1} = VP^{-j}_{jct-1}$				.0008	.0022				.00073	.076

,,*** Statistically significant at 10, 5, 1%, respectively. s.e. clustered by nyc

5 Conclusions

Earlier literature has pointed out that vertical productivity spillovers from FDI to domestic firms arise if the domestic firm serves intermediates to the foreign firm. In this study we relate the intensity of backward spillovers to the organization of multinational production in which foreign affiliates are involved. We argue that backward spillovers from FDIs are not automatic and crucially depend on the vertical integration of multinationals. The likelihood and intensity of interactions with local suppliers are lower for companies that are vertically integrated in their industry. This results in a reduced potential for productivity spillovers.

Our empirical analysis is based on a firm-level panel dataset of roughly 1 million European companies. Our results provide evidence that productivity spillover coming from vertical integrated multinationals are indeed weaker than those from non-vertically integrated FDIs. The difference in the perceived spillovers is sticking. This difference is not only statistically significant, but also economically relevant: the spillovers from FDIs that are related to other firms in local companies' industries are 2.6 to 5 times lower than those coming from not integrated FDIs.

POLICY IMPLICATIONS....

As every empirical study, our analysis has limitations. Certainly, the most relevant is the lack on observation of transaction data. Ideally, if we had information on transactions and commercial deals we could identify partnerships between local and foreign companies: this would expand the range of research questions to which a researcher might answer and allow for a finer analysis of the impact of the activity of heterogeneously organized foreign business groups on the competitiveness of local companies in the host markets. We consider these promising lines of research.

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6 Appendix

6.1 Sample validation

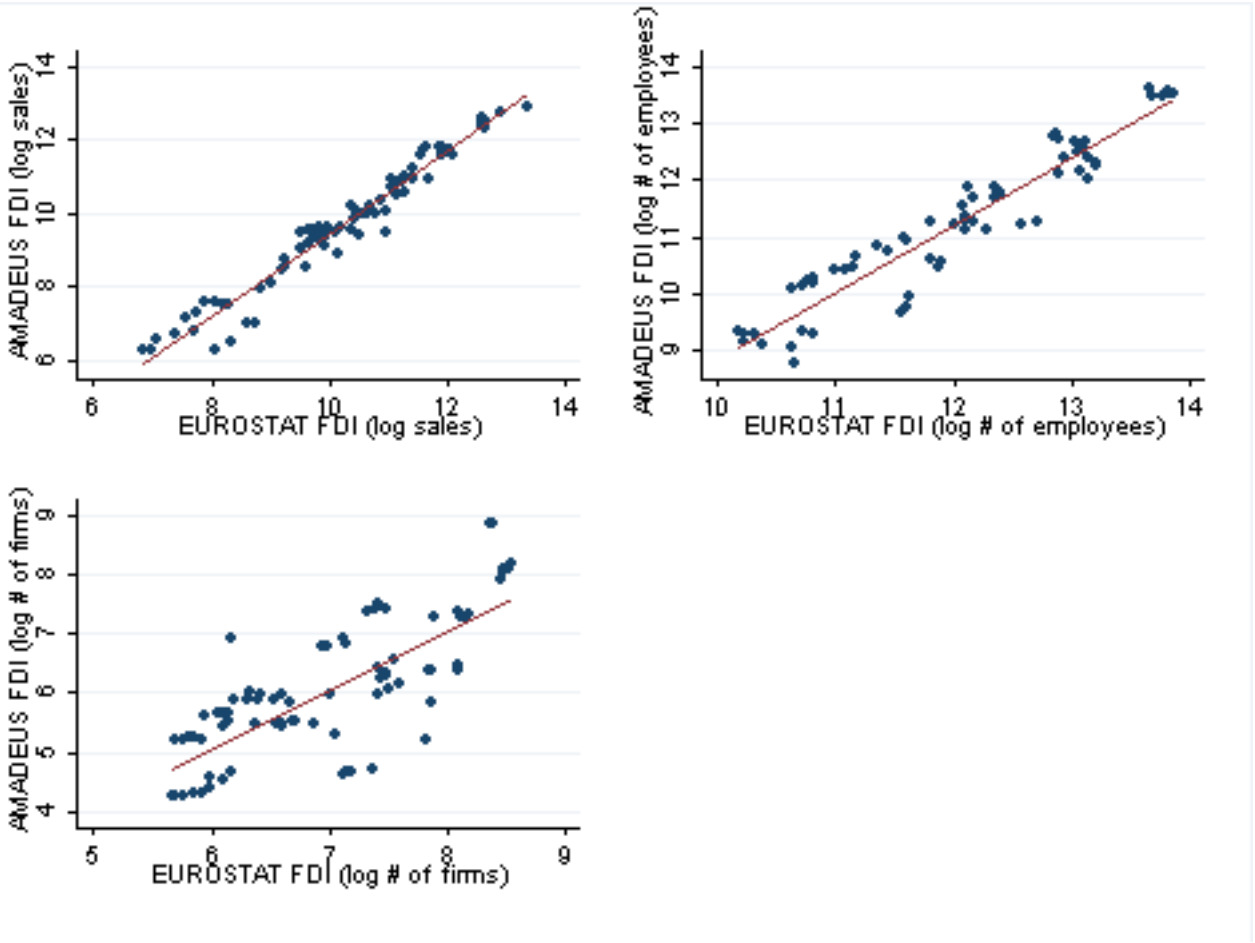

Table 9:

naics4	NrFDI	FDI	HP
Animal Food Manufacturing	487	0.04	0.13
Grain and Oilseed Milling	499	0.02	0.15
Sugar and Confectionery Product Manufacturing	590	0.05	0.34
Fruit and Vegetable Preserving and Specialty Food Manufactur	583	0.03	0.11
Dairy Product Manufacturing	527	0.02	0.16
Animal Slaughtering and Processing	464	0.01	0.05
Seafood Product Preparation and Packaging	294	0.03	0.10
Bakeries and Tortilla Manufacturing	561	0.00	0.14
Other Food Manufacturing	803	0.03	0.23
Beverage Manufacturing	1093	0.03	0.23
Tobacco Manufacturing	298	0.28	0.60
Fabric Mills	466	0.02	0.07
Textile and Fabric Finishing and Fabric Coating Mills	82.00	0.01	0.02
Other Textile Product Mills	403	0.03	0.12
Veneer, Plywood, and Engineered Wood Product Manufacturing	279.00	0.04	0.19
Other Wood Product Manufacturing	768	0.01	0.06
Pulp, paper, and paperboard mills	889	0.13	0.31
Converted Paper Product Manufacturing	2327	0.06	0.26
Printing and Related Support Activities	899	0.01	0.05
Petroleum and Coal Products Manufacturing	316	0.09	0.15
Basic Chemical Manufacturing	2044	0.17	0.36
Resin, Synthetic Rubber, and Artificial Synthetic Fibers and	1031	0.14	0.33
Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing	362	0.08	0.32
Pharmaceutical and Medicine Manufacturing	2331	0.19	0.50
Paint, Coating, and Adhesive Manufacturing	1113	0.08	0.30
Soap, Cleaning Compound, and Toilet Preparation Manufacturing	844	0.05	0.36
Other Chemical Product and Preparation Manufacturing	1334	0.10	0.27
Rubber Product Manufacturing	933	0.06	0.39
Clay Product and Refractory Manufacturing	941	0.04	0.14
Glass and Glass Product Manufacturing	1339	0.07	0.33
Cement and Concrete Product Manufacturing	1895	0.04	0.21
Lime and Gypsum Product Manufacturing	351	0.08	0.24
Other Nonmetallic Mineral Product Manufacturing	669	0.02	0.13
Iron and Steel Mills and Ferroalloy Manufacturing	886	0.12	0.55