Spillovers and Productivity: Revisiting the Puzzle with EU Firm Level Data

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Abstract

We revisit the puzzle of FDI spillovers on Total Factor Productivity (TFP) of domestic firms using evidence from six EU countries. Previous literature fails to uncover knowledge spillovers from MNEs operating in the same industry (horizontal) and upstream industries (forward) as it neglects the role of geographical proximity in the case of horizontal spillovers and the role of direct ties between domestic and foreign firms as well as the scope of product differentiation of domestic firm in the case of forward spillovers. The present paper incorporates these new aspects in the identification of horizontal and forward spillovers and shows that economic gains from the presence of MNEs in the domestic economy can be collectively close to 6.1%. Our findings provide one of the missing links highlighted in the meta-analysis of (Havranek and Irsova, 2011) and reinstate the importance of FDI as a source of productivity enhancement for local firms. From a policy perspective, our results reheat the debate about appropriate policies that increase MNEs'embeddedness within the local economy.

JEL classification: F2, O4.

Keywords TFP; MNEs; Horizontal Spillovers; Forward Spillovers; Inputs.

1 Introduction

The lack of conclusive evidence regarding the importance of FDI spillovers in Total Factor Productivity (TFP) of domestic firms prompts us to re-examine this critical issue exploring a rich data set that provides new insights into the innovation and internationalisation strategies of firms from six EU countries (Altomonte et al. 2013). MNEs are expected to generate knowledge spillovers (i.e.sophisticated technology, advanced organisational and managerial know-how, better distributional networks) that benefit TFP of domestic firms in three ways: (a) within the same

industry (horizontal spillovers), (b) as input suppliers in downstream industries (forward spillovers) and (c) as input buyers in upstream industries (backward spillovers). The size of TFP gains through either intra or inter-industry linkages remains a highly questionable issue in the FDI literature (Meyer and Sinani, 2009; Perri et al., 2013). To identify empirically FDI related spillovers is a complex exercise. In a developing country context, the absorption of foreign knowledge requires the existence of a certain capacity.[1] Within the context of developed countries, the empirical challenge is to uncover the industrial linkages (Smeets, 2008) through which domestic firms can benefit from foreign affiliates as MNEs do not always have an incentive to permit knowledge diffusion to local firms.

Görg and Strobl (2001) point out that evidence from panel data produces statistically negative effects for horizontal spillovers. Havranek and Irsova (2013) in a recent meta-analysis show that horizontal spillovers are on average statistically zero. The lack of evidence from horizontal spillovers is due to severe competition pressure and market share losses that outweigh any potential agglomeration gains from knowledge diffusion (Aitken and Harrison, 1999; Lu et al. 2017). With regard to forward spillovers, the literature documents effects that are statistically different from zero but still economically negligible(Havranek and Irsova, 2011)[2] questioning the proposition that purchasing technologically advanced inputs from MNEs in upstream industries enhances the productivity of the buyer. A possible explanation for insignificant forward spillovers is the use of protection strategies from foreign firms that prevent unwanted knowledge leakages towards domestic firms (Ha and Giroud, 2015). Substantial and economically meaningful gains for TFP of domestic firms are only found from backward spillovers as shown in the seminal studies of Javorcik (2004) and Blalock and Gertler (2008) and also confirmed in Havranek and Irsova (2011).

This paper challenges previous findings regarding the economic insignificance of horizontal and forward spillovers. We consider all possible sources of FDI related spillovers (i.e. horizontal, forward and backward) within a unified specification and show that MNEs benefit domestic firms in all possible industrial linkages. We come to this conclusion after modifying some of the conventional approaches. First, we decompose horizontal spillovers into a regional and non-regional component emphasising the role of geographical proximity in realising intra-industry spillovers and

[1] As important elements of absorptive capacity are acknowledged, among others the level of development, the quality of institutions and the existence of sufficient human capital in the recipient country (Findlay, 1978; Wang and Blomström, 1992, Coe et al. 2009).

[2] A spillover effect is defined as economically meaningful if it increases TFP of domestic firms by 1% or above (Havranek and Irsova, 2011).

second we identify two conditions that enhance productivity gains from forward spillovers.

With reference to forward spillovers, first, the size of TFP gains is analogous to the number of domestic firms that maintain a direct partnership with MNE suppliers. As the number of firms that purchase inputs from foreign firms increases, learning gains from imitation among domestic firms also increase (Newman et al, 2015). Second, the amount of tacit knowledge embodied in the technologically sophisticated MNEs' inputs is potentially beneficial for domestic firms (Bas and Strauss-Khan, 2014; Caselli, 2018) only if the latter group has a scope to differentiate their product using customized inputs. Foreign knowledge can be better absorbed in industries where domestic firms use inputs tailored to specific needs, unlike industries where domestic counterparts rely exclusively on standardised inputs. Subsequently, we hypothesise that gains from forward spillovers depend on: (a) the number of domestic firms in the downstream industry that use MNEs as input suppliers and (b) the number of domestic firms that purchase customized intermediate inputs tailored to specific product characteristics.[3]After modifying conventional indices to account for the above aspects, gains from spillovers become economically significant contributing collectively to increases in domestic TFP close to 6.1%. TFP gains from spillover effects are robust in the inclusion of additional firm characteristics that control for exporting, innovation and active outsourcing (i.e. participation in global value chains). We organise the paper as follows: section 2 outlines the data and variable definitions, section 3 discusses the econometric results and section 4 concludes the paper.

2 Data and Measurement Issues

We use the EFIGE (European Firms in the Global Economy) that gathers survey information for 2008 and balance sheet data over the period 2001 to 2014 for 7699 manufacturing firms (with 10 employees and above) in France, Germany, Hungary, Italy, Spain and UK. We define foreignness using the standard definition of a first shareholder that owns at least 10% of the capital shares and is of foreign nationality.[4] After dropping firms with missing data, the share of foreign firms in the sample is 14%, similar to figures reported in Girma et al.(2019) and Javorcik and Spatareanu (2011).Table 1 summarises the number of MNEs by country.

[3] We gather information for input suppliers and the use of customised inputs from the EFIGE Survey (Altomonte and Aquilante, 2012).

[4]The literature commonly follows the 10% definition of IMF(2009), which also provides a base of comparison between our results and previous findings.

[Table 1 here]

TFP is derived from the semi-parametric technique of Ackerberg et al., (2015) (ACF) that treats labour and capital as quasi-fixed inputs partially dependent on productivity.The ACF methodology essentially represents a revenue TFP (TFPR), which combines productivity improvements attributable to either technical change or pure price effects. As we are only interested in how knowledge spillovers impact on physical TFP (TFPQ), we isolate TFPQ from TFPR (Fons-Rosen et al.2017).[5]

[Figure 1 here]

We first construct an index of horizontal spillovers derived from the presence of MNEs within the same industry. This is written as:

$$Horizontal_{jct} = \frac{\Sigma_{F \epsilon j} S_{Fjct}}{\Sigma_{i \epsilon j} S_{ijct}} \tag{1}$$

where S denotes sales revenue of MNEs in industry j (3-digit NACE Rev.2),[6] in country c at year t. Subscript i index firms in industry j. The component of regional horizontal spillovers (*Regional*) from MNEs located within the kth region (NUTS2 classification) is:[7]

$$Regional_{kjct} = \frac{\Sigma_{F \epsilon kj} S_{Fkjct}}{\Sigma_{i \epsilon kj} S_{ikjct}} \tag{2}$$

Forward spillovers are derived from MNEs located in upstream industries that are input suppliers to domestic firms. The *Forward* index is defined as:

$$Forward_{jct} = \Sigma_{j \neq h}^{J-1} \theta_{jh} Horizontal_{hct} \tag{3}$$

where θ_{jh} is the input-output matrix coefficient that shows the amount of intermediate output used from upstream industry h to produce one unit of output in industry j. To explore whether the scope of forward spillovers depends on the direct linkages between MNE subsidiaries in upstream sectors and domestic firms in downstream

[5] Physical TFP (TFPQ) is expressed as: $\ln\text{TFPQ}_{ict} = \ln\text{TFPR}_{ict} - \ln\mu_{ict} - \ln\text{MC}_{ict}$, where μ is price mark-up and MC stands for marginal cost. We obtain estimates for μ following De-Loecker and Warzynski (2012), while MC is derived by regressing average variable cost (AVC) (i.e. the sum of wages and material expenditures over operating revenue) on a set of firm fixed effects. The coefficients of fixed effects capture how firm-specific changes over the sample period affect the total variable costs of the firm. With measures of MC, mark-up and TFPR in hand, we can obtain TFPQ.

[6] We have on average 91 3-digit industries.

[7] As (1) is the sum of regional and non-regional horizontal spillovers in industry j, the non-regional component is: $\textit{Non-Regional}_{jct} = \textit{Horizontal}_{jct} - \textit{Regional}_{kjct}$.

industries, as well as on the use of customized intermediate inputs in domestic firms, we define two variants of (3):

$$MForward^{d}_{jct} = \Sigma^{I}_{i=1} n^{d}_{jc} \Sigma^{J-1}_{j \neq h} \theta_{jh} Horizontal_{hct} \tag{4}$$

$$MForward^{q}_{jct} = \Sigma^{I}_{i=1} n^{q}_{jc} \Sigma^{J-1}_{j \neq h} \theta_{jh} Horizontal_{hct} \tag{5}$$

where n^{d}_{j} and n^{q}_{j} are the number of firms in industry j that directly purchase intermediate inputs from foreign subsidiaries in upstream sectors and use customized intermediate inputs, respectively. Analogously, we define backward spillovers from MNEs located in downstream industries and buy inputs from domestic firms in upstream industries:

$$Backward_{jct} = \Sigma^{J-1}_{j \neq w} \theta_{jw} Horizontal_{wct} \tag{6}$$

where θ_{jw} is the input-output matrix coefficient that captures the amount of intermediate output used from industry j to produce one unit of output in the downstream industry w.The input-output coefficients are time invariant and representative of the linkages across US 4-digit SIC industries for 1992 (Alfaro et al., 2019).

3 Econometric Specification

We estimate the effect of spillovers on the lnTFP of domestic firms using the following baseline specification, which is augmented interchangeably with the modified spillover indices (4) and (5):

$$\begin{aligned} \ln TFP_{ijct} \quad &= \alpha_0 + \alpha_1 Horizontal_{jct} + \alpha_2 Forward_{jct} + \alpha_3 Backward_{jct} + \\ &+ \pi^{'}_{jct} \alpha_\pi + \mathbf{x}^{'}_{ijc} \alpha_x + (\lambda_j \times \eta_t) + (\phi_c \times \eta_t) + u_{ijct} \end{aligned} \tag{7}$$

Parameters $\alpha_1, \alpha_2, \alpha_3$ represent semi-elasticities of the variables of interest. We augment (7) with vectors π and x of industry specific (time variant) and firm specific (time invariant) variables alongside with their associated parameter vectors α_π and α_x. These additional covariates provide a sense of robustness as to whether spillover effects exist conditionally to other firm and industry specific productivity drivers. We allow for industry heterogeneity that varies over time including industry-time fixed effects, $\lambda_j \times \eta_t$ and a combination of country-time fixed effects $\phi_c \times \eta_t$ that capture unobserved country idiosyncrasies and economy-wide macroeconomic shocks. Fixed effects mitigate partly the endogeneity problem that more productive firms

and industries are potentially more attractive to FDI (Abraham et al. 2010).[8] We correct for heteroscedasticity by clustering standard errors at the country and the 3-digit industry level.

[Table 2 here]

We start with a parsimonious specification (S1) in Table 2 that includes only the three spillover indices (*Horizontal*,*Forward* and *Backward*), industry-year and country-year fixed effects. Accordingly, a 10% percent increase in the presence of MNEs within the same industry increases the TFP of domestic firms by 0.81%. Economically, the highest gain is derived from backward spillovers with a 10% increase in the presence of MNEs in downstream industries to lead to a 6.8% raise in TFP of domestic firms in upstream industries. The row entitled Net Effect is the sum of economically significant spillover coefficients (i.e. $\geq 1\%$) of each specification. S2 distinguishes between regional and non-regional horizontal spillovers. Essentially, S2 uncovers whether the content of knowledge spillovers is analogous to the geographical proximity between MNEs and domestic firms (Xu and Sheng, 2012). In highly integrated product markets the adverse competition effects from MNEs are independent of geographical distance, while knowledge externalities are maximised with the agglomeration of economic activity of domestic and foreign firms. It is only the estimated parameter of *Regional* that yields economically significant gains for TFP, while the *Non-Regional* coefficient fails to exceed the critical threshold of 1%. S3 includes an industry-specific measure of market concentration (*CR*), which marginally exerts a statistically negative effect on TFP. S4 adds an array of firm-specific variables that potentially matter for productivity. All of them but *Age* are positive highlighting the importance of trade (*Exporter*),innovation (R&D) and internationalisation (*Outsourcing*) on productivity. S5 provides a further sensitivity test exploring whether gains from outsourcing through contract and arm length agreements vary across different geographical areas of the global value chain. We include four dummies taking the value one each time if more than 50% of firm i's turnover for 2008 carried out in one of the following areas: EU-15, China-India, US and Asia and zero otherwise. Estimates show that gains from outsourcing in EU-15 yield the highest productivity gains with China-India to follow. Coefficients of $MForward^{d}_{jtc}$ and $MForward^{q}_{jtc}$ in S6 and S7 are positive at the order of 2.35% and 2.5% respectively, which supports our hypotheses that the interconnection between domestic firms and MNEs suppliers as well as the use of customised inputs are

[8] Industries better endowed with human capital are more likely to receive higher FDI inflows, similarly, industry specific infrastructure can be an important determinant for the location of FDI.

necessary conditions for achieving productivity gains. Our evidence provides one of the missing links as to why MNEs in upstream industries fail to generate substantial spillovers for domestic firms (Havranek and Irsova, 2011).

4 Conclusions

We revisit the puzzle of MNEs'related spillovers with a sample of 7699 firms from six EU countries. We first show that horizontal knowledge spillovers are statistically present and economically important when the geographical proximity between domestic firms and MNEs is taken into account. Backward spillovers from MNE buyers (downstream industries) are the most considerable source of learning, while forward spillovers from MNE suppliers (upstream industries) are conditional to the number of domestic firms that purchase inputs directly from MNEs and differentiate their product using customised inputs. Our findings are not affected by the firm's individual export profile, innovation activity and active outsourcing. Two policy recommendations can be delivered from the analysis: (a) policy initiatives should have a regional focus targeting productivity enhancement of laggard regions through FDI friendly policies and (b) policies should promote schemes that rely on synergies between domestic firms and MNEs suppliers. Policy actions of this kind will stimulate the embeddedness of MNEs with local markets maximising eventually the knowledge gains for domestic firms. From a research perspective, our analysis highlights that future research in the spillovers agenda should focus on identifying the appropriate channel through which knowledge transfer occurs.

Table 1: Number of Domestic and Foreign Firms

Country	Domestic	Foreign	Sample	Foreign share (%)
FRA	1514	205	1719	11.93
GER	386	79	465	16.99
HUN	202	58	260	22.31
ITA	1971	300	2271	13.21
SPA	2137	323	2460	13.13
UK	411	113	524	21.56
Total	6621	1078	7699	14.00%

Figure 1: Evolution of TFP of Domestic Firms

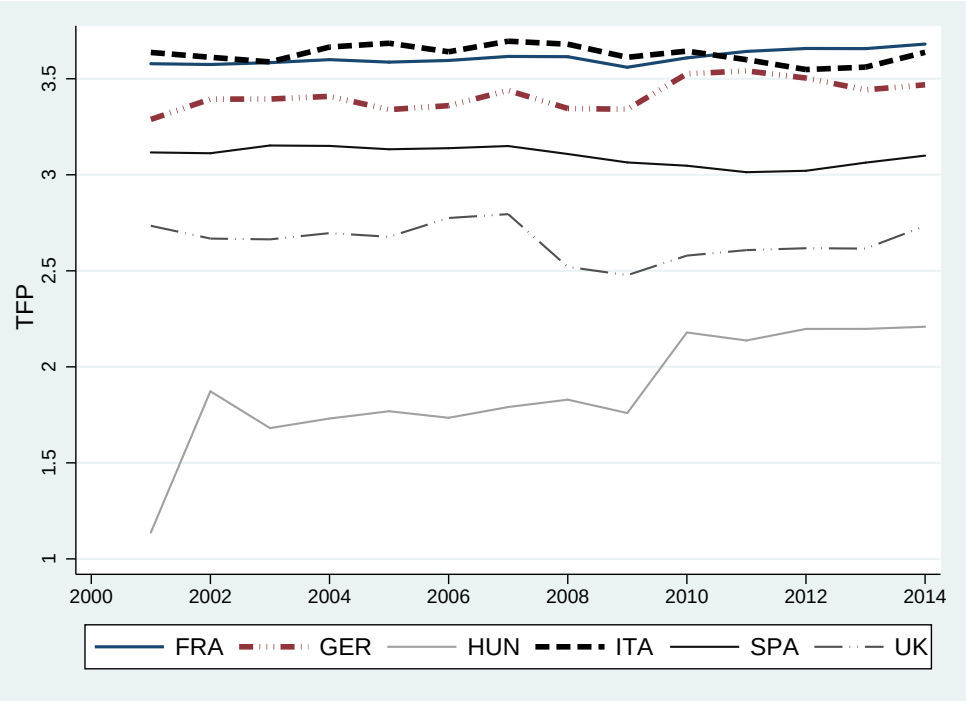

Table 2: MNEs' Spillovers and TFP. Dependent Variable: TFP of Domestic Firms

	S1	S2	S3	S4	S5	S6	S7
$Horizontal_{jct}$	0.081***						
	(0.03)						
$Regional_{jkct}$		0.126***	0.134***	0.109***	0.100***	0.100***	0.108***
		(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
$Non-Regional_{jct}$		0.069***	0.079***	0.060**	0.059**	0.064**	0.062**
		(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
$Forward_{jct}$	-0.475***	-0.475***	-0.463***	-0.482***	-0.484***		
	(0.07)	(0.07)	(0.07)	(0.06)	(0.06)		
$MForward^{d}_{jct}$						0.235***	
						(0.01)	
$MForward^{q}_{jct}$							0.250***
							(0.01)
$Backward_{jct}$	0.686***	0.684***	0.668***	0.689***	0.693***	0.205***	0.205***
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.01)	(0.02)
Net Effect	0.286	0.335	0.339	0.316	0.309	0.54	0.608
CR_{jct}			-0.058*	-0.049	-0.047	-0.034	-0.040
			(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
$Size_{ijc}$				0.410***	0.409***	0.409***	0.409***
				(0.03)	(0.03)	(0.03)	(0.03)
Age_{ijc}				-0.010	-0.010	-0.010	-0.010
				(0.01)	(0.01)	(0.01)	(0.01)
$Export_{ijc}$				0.087***	0.087***	0.088***	0.088***
				(0.01)	(0.01)	(0.01)	(0.01)
$R\&D_{ijc}$				0.043***	0.044***	0.044***	0.044***
				(0.01)	(0.01)	(0.01)	(0.01)
$Outsource_{ijc}$				0.159***		0.159***	0.158***
				(0.03)		(0.03)	(0.03)
$Outsource^{EU15}_{ijc}$					0.173***		
					(0.05)		
$Outsource^{China-India}_{ijc}$					0.138*		
					(0.07)		
$Outsource^{US}_{ijc}$					0.397		
					(0.26)		
$Outsource^{Asia}_{ijc}$					0.223		
					(0.14)		
Industry-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	79194	79194	79194	79180	79180	79180	79180
Adjusted R^2	0.3012	0.3015	0.3017	0.3219	0.3216	0.3222	0.3220
Log lik.	-63164	-63146	-63135	-61948	-61959	-61931	-61941
Clusters	8795	8795	8795	8794	8794	8794	8794

OLS estimates with standard errors in parentheses corrected at the country and the 3-digit industry level.

*** denotes 1% significance; ** denotes 5% significance; * denotes 10%.

CR is the industry concentration ratio defined by the Herfindahl-Hirschman index.

Size=1 if 0-249 employees and 0 otherwise; Age=1 if year of establishment is after 1995 and 0 otherwise.

Exporter=1 if firm exports regularly or always beofre and at 2008.

R&D=1 if firm has undertaken R&D carried out in-house.

Outsourcing=1 if firm runs at least part of its production in another country through contracts and arm length agreements.

$Outsourcing^{G}$ = 1 if 50% or above of the turnover is carried out in area G, where G=EU-15, China-India, US, Asia.

*N*et Effect is the vertical sum of economically significant (>1%) spillover coefficients.

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