# Multinationals and Domestic TFP: Market Shares, Agglomerations Gains and Foreign Ownership

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Abstract

We revisit the puzzle regarding the role of Multinational Enterprises (MNEs) on Total Factor Productivity (TFP) of domestic firms by drawing attention to foreign ownership structure. First, we differentiate between market share (MS) due to competition effects and knowledge agglomeration gains (AG). The former induces market pressure, due to foreign presence, and makes domestic firms to charge lower price mark-ups. Second, we investigate whether intra-industry (horizontal) and inter-industry (vertical) spillovers vary with the degree of foreign control. Using a sample of manufacturing firms from six European countries, we find that higher presence of MNEs in the domestic market makes domestic firms to charge lower mark-ups. Only majority and wholly-owned MNEs generate statistically significant horizontal spillovers. The economic size of these spillovers is low. We also detect backward spillovers from MNEs in downstream industries. However, forward spillovers from MNEs in upstream industries are negative. When we control for absorptive capacity, direct linkages with MNEs, scope of product differentiation and geographical proximity, the economic size of AG increases substantially.

Keywords: MNEs, Foreign ownership, Spillovers, Market Share, Agglomeration Gains, Mark-up, Total Factor Productivity

JEL Classification: D4 D24, F23, F14

## 1. Introduction

The empirical literature that examines the impact of multinational enterprises (MNEs hereafter) on productivity performance of domestic firms provides mixed and contradictory results. Early evidence from developing countries offers mainly negative results (Aitken and Harrison, 1999; Djankov and Hoekman, 2000; Konnings, 2001). With regard to developed countries, Haskel et al.,(2007) and Keller and Yeaple (2009) report gains from FDI spillovers in UK and US domestic firms, respectively. However, they consider only intra-industry measures of FDI presence[1] and neglect the possibility that knowledge spillovers can also be derived from inter-industry linkages between domestic firms and MNEs as in Javorcik (2004). The main conclusion from the existing FDI spillovers literature is that the impact of MNEs on performance of domestic firms is not straightforward and one should carefully consider the various channels through which MNEs influence economic activity of host and particularly developed countries (Greenaway, 2004; Crespo and Fontoura, 2007; Hayakawa et al.,(2012); Bournakis et al, 2019).

In this paper, we undertake this challenge and revisit the puzzle about the role of MNEs spillovers on domestic firms' productivity. We use firm level data from six European countries. The first key objective of the paper is to differentiate between structural competition effects and pure knowledge agglomeration gains, as these two are not usually explored separately leading to a misinterpretation of the true knowledge transfer effect associated with the presence of MNEs.

Competition effects are associated with the size of MNEs' and their tendency to exploit economies of scale. Domestic firms may lose market shares due to MNEs presence encountering a market-stealing effect (Aitken and Harrison, 1999; Alfaro and Chen, 2013). The loss of market share induces competition pressure that forces domestic firms to charge a lower price mark-up. Reallocation of market shares within the domestic market emerges from the presence of MNEs and it is classified as a market share (MS) effect. The MS effect is expected to be more severe for domestic firms that compete directly with MNEs subsidiaries within narrowly defined industries (Blomström et al., 2003; Alfaro and Chen, 2013).

MNEs also generate agglomeration gains (AG) in the form of knowledge spillovers (i.e. better technological know-how, enlargement of the labour pooling, advanced organisational and managerial expertise, etc.) (Poole, 2013; Bloom et al., 2013). AG impact directly on productivity of domestic firms and take place in various forms. First, we have horizontal

[1] MNEs that operate within the same industry.

spillovers that derive from MNEs, which operate within the same industry. Second, we have vertical spillovers from inter-industry supplier transactions that take the form of either forward spillovers from upstream industries or backward spillovers from downstream industries (Javorcik, 2004; Perri et al., 2013; Newman et al., 2015). The existence of horizontal spillovers remains a matter of empirical scrutiny with recent meta-analysis (Havranek and Irsova, 2013) establishing a zero effect on productivity. Indeed, the potential of horizontal spillovers depends on the ownership structure of MNEs as the latter determines the scope and the opportunities for knowledge transfer from foreign to domestic firms.[2] With regard to vertical spillovers, the existing evidence suggests positive backward spillovers (Rojec and Knell, 2018; Javorcik and Spatareanu, 2011). However, empirical findings as regards the size of forward spillovers is less clear with their effect to be economically negligible or even negative (Havranek and Irsova, 2011).

Our paper offers three main novelties. First, we provide new insights on the debate of FDI spillovers by distinguishing the MS effect from AG. Within our methodological framework, we identify how price mark-ups of domestic firms are driven by the presence of MNEs. Higher output shares of MNEs within the same industry are expected to decrease market power of domestic rivals, which is reflected into lower price mark-ups. The MS effect represents essentially a favourable competition effect with important welfare implications for consumers of the recipient economy. In identifying knowledge AG, we isolate pricing effects from technology, so increases in the productivity of domestic firms' capture only technical improvements that can be attributed to gains from knowledge spillovers.

Second, we propose a novel FDI spillover index to capture AG on domestic productivity. Earlier studies measure the presence of MNEs in the domestic market with the share of total inward FDI to industry's total output.[3] Recently, Javorcik and Spatareanu (2008), Keller and Yeaple, (2009), Lu et al., (2017) and Fons-Rosen et al., (2017) measure spillover indices by using the sum of weighted output of foreign firms as share of total output in the industry. Although gross output or sales revenue capture the presence of MNEs in the domestic market, they do not provide information as regards the evolution of technological progress in MNEs. The main source of knowledge spillovers is the technological superiority of MNEs, which is not necessarily embodied in a pure weighted measure of gross output. Therefore, we create

[2] Evidence in favour of horizontal spillovers is found in Blomström and Kokko (1998); Bwalya (2006); Javorcik and Spatareanu (2008); Blalock and Gertler (2009); Abraham et al. (2010). Nonetheless, all these studies highlight that the size of horizontal spillovers is conditional on the degree of absorptive capacity of domestic firms.
[3] See for example Liu et al. (2000); Girma (2005); Driffield and Love (2007).

FDI-related spillovers adjusted for Total Factor Productivity (TFP) of MNEs. TFP is the closest approximation of technical change (Stiroh, 2001; Link and Siegel, 2003)[4], thus conceptually represents more accurately how the evolution of TFP in MNEs induces gains for domestic firms in the form of horizontal or vertical spillovers.

Third, following a recent line of research by McCaughey et al. (2018) this paper links the existence of knowledge spillovers to the degree of foreign ownership in MNEs. The ownership status is central in identifying horizontal spillovers as it determines the scope and the incentives for transferring knowledge and intangible assets from the MNE parent to its subsidiary. The commonly used definition of 10% (or above) foreign ownership (IMF, 1993; 2009) does not necessarily capture all possible scenarios about the position of a foreign affiliate within the MNE group (Ramstetter and Ngoc, 2013; Chang et al., 2013; Papanastassiou et al., 2019). We argue that definitions of foreignness that are restricted only to higher thresholds might be more influential for the existence of knowledge spillovers. The way that the degree of foreign ownership works for knowledge spillovers is not always straightforward. In theory, a scheme of minor foreign ownership with the participation of a local shareholder makes the adoption of foreign technology easier (Blomström and Sjöholm, 1999).[5] In a shared partnership MNEs' managers are less restrictive in preventing technology leakages, so technology diffusion from foreign firms to local partners can be more easily implemented (Inkpen, 2000). The local partner can then use the technology acquired from the MNE into projects not involving the participation of the foreign firm, thus spreading the advanced technology more easily in the domestic market. In the case of a majority or a wholly-owned foreign subsidiary, access to the technology from domestic firms seems to be more difficult. However, knowledge transfer can still take place as a response to pressures triggered by the "liability of foreignness" (Zaheer, 2015). The latter term refers to the occurrence of additional sunk costs for establishing networks in the host market, non-existent for domestic firms. Overcoming the burden of these costs requires the transfer of firm-specific advantages from the parent to the affiliate with the former to maintain the rights on how these assets will be used (McGaughey et al., 2018). In other words, MNEs will more likely transfer technologically sophisticated assets to their affiliates if their share of ownership safeguards a tighter control over these assets (Guadalupe et al., 2012; McGaughey et al., 2018). Nonetheless, as contracts are inevitably incomplete,

[4] TFP measures are derived from a production function framework, which measures directly the degree of efficiency in the process of transferring inputs into output (Link and Siegel, 2003).

[5] Other studies supporting the argument that technology diffusion is more easily implemented in a shared partnership mode can be found in Malerba and Torrisi (1992) and Castellani and Zanfei (2002).

productivity spillovers towards domestic firms are still possible even from fully owned foreign affiliates (Hart, 2017). Another aspect that increases the likelihood of knowledge diffusion from MNE affiliates that operate under increased foreign ownership is the de-motivation of managers in safeguarding firm-specific proprietary assets as all key decisions related to the operation of the subsidiary are delegated to the headquarters (Foss et al., 2012).[6] With these considerations in mind, one might expect that majority or fully owned foreign affiliates can also generate substantial knowledge spillovers that might be potentially larger than those derived from MNEs with a looser definition of foreignness.

To examine how the size of spillovers varies across definitions of foreign ownership, we use data of foreign ownership from the *European Firms in the Global Economy* (EFIGE) dataset to define: (a) a minor threshold (10-49%) of foreign ownership; (b) a majority threshold (50-99%) of foreign ownership; (c) a full (100%) foreign ownership. Our main goal is to identify whether the ownership structure of the foreign firm is central in exerting spillovers to domestic firms. Our definition of what is a foreign firm differs from the standard approach in the literature that applies a unified single threshold definition of foreign ownership throughout the analysis. Chang and Xu (2008) use a 25% threshold of equity to define a firm as foreign, Zhang et al. (2010) consider a 100% threshold of foreign equity. However, there is no evidence on how spillovers vary across alternative definitions within the same analytical framework. [7] In our context, we produce results for MS effects and AG considering each time a different definition of foreignness.

Using a sample of manufacturing firms from six EU countries, we find that increased competition resulting from MNEs presence forces domestic firms to charge a lower price mark-up. We detect horizontal spillovers only from wholly owned foreign MNEs and to a lesser extent from majority owned MNEs. Horizontal spillovers become economically significant only if we take into account the absorptive capacity of domestic firms measured by intangible capital. Geographical proximity between domestic and foreign firms is also a factor that increases the potential of horizontal spillovers. Vertical spillovers in general seem are independent from foreign ownership structure. Backward spillovers from MNEs in downstream industries are positive, while forward spillovers from upstream industries are

[6] Full foreign ownership of the MNE affiliate refers not only to the control of assets but also to the rights on the use of the residual income generated from these assets. This ownership mode creates an interventional hazard through a standard principal-agent problem which results in unintended diffusion of technology due to lack of incentives in the foreign affiliate (Grossman and Hart, 1986; Hart,1995).

[7] To the best of our knowledge, only McCaughey et al. (2018) evaluate the size of horizontal spillovers considering within the same analysis alternative definitions of foreignness based on the degree of foreign participation in the MNE subsidiary. Our study extends this approach evaluating knowledge gains from all possible spillovers.

initially negative. Once we control for direct linkages with MNEs in upstream sectors and the use of customised inputs, positive forward spillovers are also found. To mitigate issues related to endogeneity and reverse causality, we follow a difference in differences econometric approach, which verifies that the pattern of MNEs related spillovers found in the baseline econometric specifications are consistent.

The paper is organised as follows: section 2 discusses data and measurement issues. It also elaborates on the creation of TFP spillover indices that measure the effects from MNEs presence. Section 3 provides the econometric specifications of the paper. It also provides baseline results as well as estimates from specifications that account for absorptive capacity, firm characteristics and geographical proximity. Section 4 shows the robustness analysis with a difference in differences identification strategy to control for endogeneity bias and other possible unobserved measurement errors. Section 5 concludes the paper.

## 2. Data and Measurement Issues

### 2.1 Data Coverage: A Brief Description of the EFIGE Dataset

The data provider of EFIGE is Bruegel, a Belgian non-profit international association that collects survey and balance sheet information from 7699 manufacturing firms (with 10 employees and above) for six EU countries, France, Germany, Hungary, Italy, Spain, UK over the period 2001-2014 within a unified database.[8] The EFIGE survey information is drawn from a questionnaire of 150 items covering six broad areas of firm economic activity: structure of the firm, workforce, innovation, internationalization, market structure and finance (Altomonte and Aquilante, 2012; Altomonte et al., 2013).[9] Although the EFIGE survey was conducted in 2008, the balance sheet information is available from 2001-2014. With reference to the questions of the EFIGE survey, three are important for our analysis. The first one is based on information regarding the ownership structure of the firm. The other two are related to information used to investigate firms' characteristics that might be important for the realization of forward spillovers. Specifically, we use question D30A: *Has the firm purchased raw*

[8] The initial EFIGE database includes 14579 firms. We exclude Austria and a substantial number of firms in other countries due to missing data in balance sheet variables that are needed for estimating the production function. The data clearing process reduced the number of firms to half.

[9] Some additional points regarding the EFIGE dataset are also in demand: (i) The final sample of firms is somehow biased towards large firms; (ii) The correlation of the sample in an array of variables (employees, revenue, wages) is very similar to firm level data set published by Eurostat (Structural Business Statistics for manufacturing firms with more than 10 employees).

*materials or any intermediate goods for its domestic production in 2008*? Based on the responses, we define a binary variable receiving ones if the firm has purchased materials or goods from a foreign firm and zero otherwise. The second variable is based on question D36: *Has the firm purchased any intermediate goods*? The possible answers are, raw materials, standardized intermediates and customized intermediaries. We define a binary variable on whether firms have purchased customized intermediaries.

2.2 Definitions of Ownership and measures of TFP

Information for MNE ownership is drawn from EFIGE based on the share of capital of the first shareholder.[10] We define ownership by the fraction of capital shares owned by the first shareholder in 2008. We use three alternative definitions of foreign ownership: MNE10 includes firms in which the first shareholder is of foreign nationality and owns at least 10% but less than 50% of the capital shares; MNE50 definition includes firms in which the first shareholder is of foreign nationality and owns at least 50% but less than 100% of the capital shares; MNE100 includes firms in which the shareholder is of foreign nationality and owns 100% of the capital shares. Domestic firms are those whose 100% of the capital shares are owned by domestic shareholders.[11]Therefore, each of the three definitions of foreign ownership includes a different group of foreign firms. The MNE10 uses as foreign ownership threshold the standard lower bound of 10% commonly used in the literature, nonetheless it excludes firms in which the foreign affiliate owns the majority of the full amount of shares. MNE50 and MNE100 definitions capture tighter control of the foreign affiliate from its parental, which might also embody different motives in the decision of technology transfer (Guadalupe et al., 2012; Girma et al., 2019). As information for MNE ownership is drawn from a single year (i.e. 2008), it is implied that the number of foreign firms across different definitions of foreignness as well as the number of domestic firms do not change over time.[12] Table 1 summarises the number of MNEs across different definitions of foreignness by country. After dropping firms

[10] The EFIGE ownership data refer to the largest three shareholders allowing us to follow a direct ownership chain (UNCTAD, 2016). The owner can be of any legalistic form: Individual, Industrial Firm, Holding firm, Public Entity, Bank or Insurance Company.

[11] We do not include domestic MNEs to maintain a sample of purely domestic firms.

[12] It is a common practice to use information from a single year to define ownership in a panel context (Konnings, 2001; Navaretti et al., 2014; Navaretti et al., 2019). This might induce some measurement bias if there are substantial alterations in the structure of capital shares before and after 2008. This type of measurement bias and unobserved endogeneity is more systematically treated in section 4.

due to missing data, the share of all foreign firms in the sample regardless the definition of ownership is close to 23%,[13] similar to those reported in Girma et al.(2019), Javorcik and Spatareanu (2011) Karpaty and Lundberg (2004).[14]

[Insert Table 1]

We estimate TFP using the semi-parametric technique of Ackerberg et al., (2015). Accordingly, this procedure allows for a dynamic specification in the selection of the inputs of capital and labour. Contrary to the previous semi-parametric techniques of Olley and Pakes (1996) and Levisohn and Petrin (2003), Ackerberg et al., (2015) assume that labour and capital are both quasi-fixed inputs that are partially dependent on productivity. Appendix A1 outlines the key steps of the Ackerberg et al., (2015) methodology. Furthermore, the TFP derived from Ackerberg et al. (2015) represents essentially revenue TFP (TFPR), which combines influences from technical change and prices. We need to deflate TFPR in order to obtain a measure of physical productivity (TFPQ) (De Loecker et al. 2016) that will help us to understand the true effect of knowledge spillovers on productivity of domestic firms. In absence of price data deflators, we use an alternative methodology to isolate TFPQ from TFPR. We explain this methodology in detail in Appendix A5. All measures presented throughout the paper refer to TFPQ.

[13] EFIGE data set is by construction biased toward large firms (Altomonte & Aquilante, 2012; Navaretti et al., 2014) that are more likely to be MNEs.

[14] In Girma et al. (2019), the proportion of foreign firms in Chinese data is 21.1%, in Javorcik and Spatareanu, (2011) the share in Romanian data is 19.5% and in Karpaty and Lundberg (2004) the share of foreign firms in Swedish data is 17.1%.

2.3 Market Share and TFP Spillovers

We now proceed with the measurement of variables that capture MS effects and AG from MNEs. We first define the MS variable, which is associated with the presence of MNEs in the same industry. We also define indices of horizontal spillovers derived from MNEs within the same industry and vertical spillovers, in the form of either forward spillovers from MNEs in upstream industries or backward spillovers from MNEs in downstream industries.

The MS variables is defined as:

$$s_{Fjt} = \frac{\sum_{F \in j} S_{Fjt}}{\sum_{i \in j} S_{ijt}} \quad (1)$$

where $s$ is the ratio of sales revenue $S$ of MNEs $F$ to total sales revenue of all firms $i$ in industry $j$ (3-digit NACE Rev2) at year $t$ (country index $c$ is supressed for readability). This index is similar to the variable that is commonly used in the literature to capture horizontal spillovers (Javorcik, 2004; Ha and Giroud, 2015; Newman et al.,2015; Lu et al.,2017; Fons-Rosen et al., 2017). [15] Nonetheless, in our econometric framework, $s_{Fjt}$ will account for the level of competition pressure induced by MNEs within the same industry. In this case, higher levels of $s_{Fjt}$ are expected to make domestic firms charge a lower price mark-up.

Turing to AG indices, we differentiate our approach from the standard norm in the literature by using TFP adjusted spillover indices that embody information about the evolution of technical change in MNEs. To capture horizontal spillovers, we use the sum of TFP adjusted market share of MNEs operating in industry $j$:

$$H_{jt} = \sum_{F \in j} s_{Fjt} TFP_{Fjt} \quad (2)$$

where $s$ is the market share as defined in (1) and $TFP_{Fjt}$ is the TFP of MNE $F$ in industry $j$ at year $t$. The value of $H_{jt}$ increases either because MNEs increase their share of sales in industry $j$ or because MNEs experience a higher level of technical progress.

Vertical spillovers can be either backward or forward. Vertical Forward ($VF$) spillovers are derived from MNEs located in upstream industries that supply inputs to domestic firms. $VF$ are defined as:

$$VF_{jt} = \sum_{j \neq h}^{J-1} \gamma_{jh} H_{ht} \quad (3)$$

[15] The variables used to measure the FDI presence in the domestic country vary from gross output (Javorcik, 2004; Yu et al, 2017) to R&D expenditures (Ha and Giroud, 2015).

Where $\gamma_{jh}$ is the input-output matrix coefficient that captures the amount of intermediate output purchased from upstream industry *h* in order to produce one unit of output in industry *j* at year *t*. $H_{ht}$ is a measure of TFP adjusted horizontal spillovers in the upstream industry. Analogously, vertical backward (*VB*) spillovers are derived from MNEs located in downstream industries that purchase inputs from domestic firms. *VB* are defined as:

$$VB_{jt} = \sum_{j \neq w}^{J-1} \gamma_{jw} H_{wt} \quad (4)$$

Where $\gamma_{jw}$ is the input-output matrix coefficient that captures the amount of intermediate output purchased from industry *j* in order to produce one unit of output in the downstream industry *w*. Coefficients $\gamma_{jh}$ and $\gamma_{jw}$ are time invariant parameters that represent US input-output coefficients across 4-digit SIC industries for the base year of 1992 (Alfaro et al., 2019).[16] As the key goal of the paper is to uncover whether the size of knowledge transfer varies with the degree of foreign ownership, we calculate indices (1) to (4) for each one of the definitions of foreign ownership (i.e. MNE10, MNE50, and MNE100).

[16] The industrial classification in the EFIGE dataset follows NACE Rev2. Therefore, we had to convert the input-output coefficients from SIC-US, which is the classification pattern in Alfaro et al. (2019) into NACE Rev2. This procedure was implemented in two steps. First, we match codes between SIC-US and ISIC Rev4 and then we converted industry codes from ISIC Rev4 to NACE Rev2. At the end, we map the 4-digit NACE Rev2 industries into their 3 digit pattern to fit the EFIGE industrial classification. An alternative less laborious strategy is to use directly the Leontief input-output matrices from OECD (Input-Output database). The main shortcoming of this method is that OECD input-output matrices are provided at an aggregated 2-digit level, thus less accurate for capturing inter-industry linkages at the 3-digit level.

## 3. Estimation Strategy and Results

### 3.1 Econometric Specification

To search for MS effects on the pricing behaviour of domestic firms, we use an econometric specification with the natural log of price mark-up $\mu$ of domestic firms as the dependent variable: [17]

$$\ln \mu_{ijt} = \alpha_0 + \alpha_1 s^{F}_{jt-1} + \alpha_2 CR_{jt-1} + \mathbf{x}'_{ijt-1}\boldsymbol{\alpha}_x + \mathbf{z}'_{ij}\boldsymbol{\alpha}_z + \theta_c + \eta_j + \nu_t + u_{ijt} \qquad (5)$$

*i* indexes domestic firms, *j* indexes 3-digit NACE Rev 2 industries, and *t* stands for time. The variable of interest, $s_{Fjt}$, measures the market share of MNEs in industry *j*. This regression framework allows us to relate FDI competition effects with price mark-ups of domestic firms. In this sense, parameter $\alpha_1$ captures the premium of higher FDI presence in industry *j*. *CR* is the Herfindahl-Hirschman Index that measures market concentration in industry *j*. Recent literature points out that mark-up heterogeneity is driven by a number of firm specific factors such as productivity and product differentiation. Productivity represents technical efficiency that might pick up additional variation in the pricing behaviour (Katayama et al., 2009; De Loecker, 2011; Edmond et al.,2015),[18] so ln*TFP* of domestic firms is also included in vector **x**. We also control for a firm's scope to invest in product differentiation, which enhances the ability of a higher mark-up (Hornok and Muraközy, 2019). Other time variant and firm specific controls included in vector **x** are the leverage ratio (LEV), defined as total liabilities over total assets and the intangibles ratio (INTA) defined as the share of fixed intangible assets over total fixed assets. Leverage ratio represents firm's tendency to use external finance for product investment; similarly, intangibles ratio shows firms ability to improve product characteristics. Both controls are associated with product differentiation, which potentially rotates demand curve outwards making producers to face a less elastic demand thus charging a higher mark-up. Finally, specification (5) includes a vector **z** of time invariant firm characteristics: a size dummy (SME) taking the value of 1 if *i* is a small-medium sized firm and zero otherwise,[19] an age dummy (AGE) taking the value of 1 if firm *i* was established after 1995 and zero otherwise

[17] We adopt the De-Loecker and Warzynski (2012) methodology for the derivation of $\mu$. A brief illustration of this methodology is shown in Appendix A5.
[18] See Restuccia and Regerson (2008) and Hsieh and Klenow (2009) for some novel work on the link between TFP and the misallocation of resources.
[19] A firm is defined as SME if the number of employees is between 50 and 249, (OECD, 2005).

and an export dummy (EXP) taking the value of 1 if *i* reports export sales in all years of the sample and zero otherwise. Vectors $\boldsymbol{\alpha}_x$ and $\boldsymbol{\alpha}_z$ include parameters to be estimated for firm specific, time variant and time invariant characteristics. The econometric specification is also augmented with country ($\theta_c$), industry ($\eta_j$) and time fixed effects ($\nu_t$). Finally, $u_{ijt}$ is the error term of the regression. The time variant variables of the right-hand side (Rhs) in (5) enter the regressions in one year lag so they can be considered as predetermined.

Turning to the investigation of AG on productivity of domestic firms, the dependent variable in specification (6) is the natural log TFP of domestic firms:

$$\begin{aligned} \ln TFP_{ijt} = \beta_0 + \beta_1 H_{jt-1} + \beta_2 VF_{jt-1} + \beta_3 VB_{jt-1} + \beta_4 CR_{jt-1} + \\ + \mathbf{x}'_{ijt-1}\boldsymbol{\beta}_x + \mathbf{z}'_{ij}\boldsymbol{\beta}_z + \theta_c + \eta_j + \nu_t + e_{ijt} \end{aligned} \quad (6)$$

$H_{jt-1}$ , $VF_{jt-1}$ and $VB_{jt-1}$ are the variables of interest that measure horizontal, forward and backward spillovers, respectively. The rest of variables in (6) are already defined and discussed above. The Rhs variables in (6) are also in one year lag. The use of predetermined variables is in line with the assumption of weak exogeneity between $\text{Rhs}_{ijt}$ regressors and $e_{ijt}$, $E[Rhs_{ijt-1}, e_{ijt}] = 0$ and accounts also for some delay in the impact of MNEs on domestic TFP. Nonetheless, endogeneity bias still persists if future shocks affect contemporaneous values, $E[Rhs_{ijt}, e_{ijt+1}] \neq 0$ or if there are omitted factors in the Rhs that matter for TFP in equation (6). The issue of endogeneity bias is more systematically addressed in section 4.

## 3.2 Results from Benchmark Specifications

### 3.2.1 Market Share Effects

Table 2 shows regression estimates of specification (5) for each definition of foreign ownership. Heteroscedasticity is a matter of particular concern in our econometric model, as our dataset consists of observations of firms that vary across countries and industries. To mitigate this issue, we apply a Generalised Least Squared (GLS) estimator. The coefficients reported in Table 2 can be interpreted as semi-elasticities as mark-ups are expressed in natural logs with the majority of the Rhs variables to be ratios unless stated otherwise. Robust standard errors in parentheses are clustered at the country and industry level. As there is time dimension in our panel, we also allow for first order serial correlation in the $u_{ijt}$.

[Insert Table 2]

We first observe that coefficient estimates for $s_{jt-1}$ are negative and statistically significant at the five and ten percent confidence level and they do not vary substantially across different definitions of foreign ownership. This suggests the enhancement of competition is due to higher shares of MNEs in domestic industries. The economic size of this effect remains modest, as a 10 percent increase in the market share $s_{jt-1}$ of wholly owned MNEs (column 3) leads domestic firms to charge on average a 2.1% lower price mark-up. Given that the effect of MNEs on mark-ups of domestic firms is robust across different definitions of foreign ownership, we can conclude that the MS effect from FDI generates some positive welfare gains for the domestic economy (especially in terms of consumer surplus), albeit the size of these competition gains is economically low.[20] The coefficient estimate of the other industry specific variable in Table 2, $CR_{jt-1}$ suggest that highly concentrated industries reap monopolistic power that leads to higher mark-ups. Interestingly, $\ln TFP_{ijt}$ exerts a negative effect on price mark-ups. The latter finding means that productivity gains resulting from a more efficient allocation of the production resources favour a competitive pricing behaviour.[21] More importantly, with

[20] In the meta-analysis study of Havranek and Irsova (2013), a coefficient of an FDI related spillover lower than 0.1 is considered as economically unimportant despite being statistically significant.

[21] Admittedly, the relationship between $\ln\mu$ and $\ln TFP$ might be subject to feedback effects, so the respective estimates can be misleading due to sizeable endogeneity bias. We do not consider this as a central issue to our research as our main objective in specification (5) is to unveil whether there are MS effects related to MNEs after controlling for all possible covariates. To the best of our knowledge, a specification that directly evaluates the MNEs' effect on price mark-ups of domestic firms has not been done previously.

reference to our main research question, MNEs induced competition gains capture some variation in the evolution of price mark-ups of domestic firms even after controlling for productivity. Firms with high degree of leverage (*LEV*) tends to charge higher prices. This result could likely reflect that external borrowing is a channel of investment for product quality improvements (i.e. purchase of better quality inputs) that potentially leads to a higher price mark-ups (Konnings et al., 2005). An intensive use of intangibles assets (*INTA*) is also associated with higher mark-ups signifying that firms shape competitive advantage on the basis of product differentiation that justify higher mark-ups. Product quality as a factor of within industry mark-up heterogeneity is also highlighted in Kugler and Verhoogen (2012). SMEs charge lower mark-ups than large firms while the opposite is true for young firms (AGE), suggesting that competitive pricing behaviour is analogous to the age of the firm. We interpret this as a pure age effect that reflects efficiency gains from learning and accumulation experience. Finally, domestic exporters (EXP) charge lower mark-ups, a finding that echoes prior theoretical work on the positive role of export orientation in pricing behaviour (Bernard et al., 2003; Melitz and Ottaviano, 2008). Accordingly, trade integration stimulates competition among international producers, which also feedbacks into the structure of the domestic market with exporters to charge overall lower prices.[22] Finally, producers adjust their price mark-ups downwards the years of the global financial crisis, as shown by the coefficients dummies of 2008 -2009.

### 3.2.2 Agglomeration Gains

Turning to the estimation of AG in Table 3, the variables of interest are $H_{jt-1}$, $VF_{jt-1}$ and $VB_{jt-1}$. To provide a basis of comparison with findings in the FDI spillovers literature, we first use a set of baseline specifications with spillover variables not adjusted for TFP that are identical to indices used in Javorcik (2004) and Newman et al.(2015), among others. The non-adjusted TFP index of horizontal spillovers accounts only for the sales share of MNE subsidiaries' in each industry like index (1) ($VF_{jt}$ and $VB_{jt}$ are defined analogously).

The coefficient of non-adjusted $H_{jt-1}$ in Panel A (Table 3) is statistically insignificant in all definitions of foreign ownership. Coefficient estimates of forward spillovers $VF_{jt-1}$ from

[22] Our results oppose those of De Loecker and Warzynski (2012) and Zhang and Zhu (2017) showing that exporters charge higher mark-ups due to their higher productivity performance vis-a-vis that of their domestic rivals.

upstream industries are significantly negative, while backward spillovers $VB_{jt-1}$ from downstream industries are positive and statistically significant. The coefficient of $VB_{jt-1}$ is 0.188, which is relatively smaller than the average value of 0.307 for backward spillovers in firm level studies (Havranek and Irsova, 2011). Given that the dependent variable is ln$TFP_{ijt}$, the point estimate of $\widehat{VB_{Jt-1}}$ under MNE100 can be interpreted as semi-elasticity, accordingly a 10% percent increase in the market share of MNEs in downstream industries increases TFP of domestic firms by 1.88%.[23] Nonetheless, negative forward spillovers ($VF_{jt-1}$) from MNE suppliers in upstream industries are negative with the point estimate of $\widehat{VF_{Jt-1}}$to indicate that a 10% increase in the market share of wholly owned MNEs in upstream industries decrease domestic TFP by 1.45%. Note, the average effect from forward spillovers in the literature is close to 0.7% (Havranek and Irsova, 2011). The net effect from vertical spillovers $(VF_{jt-1} + VB_{jt-1})$ remains positive within the range of 0.16% and 0.46%. The negative coefficient of $VF_{jt-1}$ is a result that merits additional investigation in the upcoming section.

Turning to Panel B (Table 3) with TFP adjusted spillovers[24] (definitions in (2), (3) and (4)), horizontal spillovers are detected from majority (MNE50) and wholly owned (MNE100) MNE subsidiaries. Indicatively, a 10% increase in the presence of wholly owned MNEs increases TFP of domestic firms within the same industry by 0.21%.[25] The size of TFP adjusted horizontal spillovers is smaller than $VB_{jt-1}$ in Panel B and still below the one percent threshold defined as a rule of thumb for the realisation of reasonably meaningful economic gains from FDI spillovers (Havranek and Irsova, 2013). In sum, horizontal spillovers of low economic significance are detected under the strict definitions of foreign ownership (MNE50 and MNE100) and only if MNEs' sales share is adjusted for TFP. This is preliminary evidence that horizontal spillovers depend on the ownership structure of MNEs as the latter determines motives and prospects of knowledge transfer from the parental to the MNE subsidiary. It bears noting that estimates of Table 3 are not driven by differences in sample sizes as the number of domestic firms remains the same regardless the definition of the foreign firm.

[23] The size of backward spillovers in the literature varies with the level of development of the economy under study. Although the average value in the meta-analysis of Havranek and Irsova (2011) is 0.307 this coefficient might vary substantially. For example, the coefficient of backward spillovers for Chinese firms is 0.54 (Lu et al., 2017), 0.43 for Vietnamese firms (Newman et al.2015), 0.087 for Indonesian firms (Blalock and Gertler, 2008) and between 0.03 and 0.07 for Lithuanian firms (Javorcik, 2004). The present point estimate for EU countries indicates remarkable TFP gains from linkages with MNEs in downstream industries that sometimes exceed gains realised in developing and emerging markets.

[24] As mentioned, the measure of TFP adjusted is more informative about the evolution of technical change in foreign firms and the potential of technology transfer from MNEs to domestic counterparts.

[25] Havranek and Irsova (2013) consider as economically significant effects from horizontal spillover that exceed 0.1. According to this definition, our coefficient of $H_{jt-1}$ in Panel B is negligible despite its statistical significance.

Coefficient estimates of vertical forward and backward spillovers ($VF_{jt-1}$ and $VB_{jt-1}$) in Panel B are close to those reported in Panel A both in terms of magnitude and significance. The average net effect of TFP adjusted spillovers ($H_{jt-1}+VF_{jt-1}+VB_{jt-1}$) across all ownership structures is close to 0.03 indicating that a 10% increase in the presence of MNEs leads to a rise in the TFP of domestic firms' by 0.3%. Overall, the size of AG is economically unimportant, a finding that is mainly driven from the negative impact of forward spillovers.

[Insert Table 3]

Turning to coefficients of the other controls, the $CR_{jt-1}$ index exerts a negative effect on TFP implying that market concentration is associated with insufficient competition among firms leading to a non-optimal use of the resources and, thus lower productivity. The coefficient of $LEV_{ijt-1}$ is also negative signifying that external funding is not always related to productivity enhancing investment.[26]The coefficient of $INTA_{ijt-1}$ is positive, with a 10% increase of in-house investment in intangible capital to lead to a 0.4% increase in TFP. Interestingly, the size of this effect is lower than the one exerted by $VB_{jt-1}$, and slightly above than that of $H_{jt-1}$. Finally, domestic SMEs and exporters exhibit superior productivity performance than large firms and non-exporters, while newly established firms tend to have lower TFP, consistent with well-established evidence on the impact of age, size and exporting on firm performance (Majumdar, 1997; Zhang and Zhu, 2017).

## 3.3 Further Specifications

### 3.3.1 Horizontal Spillovers and Absorptive Capacity

Estimates of previous section illustrate that horizontal spillovers, $H_{jt-1}$ are not detected under the MNE10 definition of foreign ownership. Likewise, under stricter definitions of foreign ownership, their economic magnitude, while statistically significant, is low. Another striking finding that emerged in the previous section is the negative coefficient of forward spillovers $VF_{jt-1}$. To further elaborate on these results, we first link the existence of horizontal spillovers to absorptive capacity of individual firms. The rationale behind this exploration is that benefits from intra-industry knowledge spillovers might be analogous to the degree of technological

[26] We also experiment with a quadratic term of leverage as in Coricelli et al. (2012) to unveil any non-linear effects. However, we do not find any significant relationship between TFP and the squared term of leverage (results are available upon request).

similarity between domestic firms and foreign subsidiaries. Keller and Yeaple (2009), Javorcik and Spatareanu (2008), Havranek and Irsova (2013) and Bloom et al., (2013) claim that horizontal spillovers are largely driven by the technological profile of the industry[27] and on the degree of technological closeness between domestic firms and MNEs.[28] In other words, horizontal spillovers are triggered with the ability of domestic firms to absorb knowledge from entities that are more technologically advanced. We account for absorptive capacity using intangible assets that represent the in-house effort of domestic firms to build a critical mass of technological expertise. Empirically, we augment (6) with an interaction term between intangible capital $INTA_{ijt-1}$ and $H_{jt-1}$ to test the hypothesis that the horizontal spillovers increase with the level of in-house investment in intangible capital of domestic firms.

[Insert Table 4]

Table 4 shows that the linear term of $H_{jt-1}$ remains statistically insignificant, similarly the autonomous impact of $INTA_{ijt-1}$ is also low, 0.05. However, the coefficient of the interaction term $H_{jt-1}\times INTA_{it-1}$ is positive and statistically significant, even at the low threshold of foreign ownership, MNE10. To calculate the semi-elasticity of $H_{jt-1}$ from the composite effect of absorptive capacity, we differentiate $\ln TFP_{ijt}$ with respect to $H_{jt-1}$. From specification (3) in Table 4, we derive an effect of horizontal spillovers that is equal to 2.57.[29] This indicates substantial productivity gains both in statistical and economic terms. Precisely, a 10 percent increase in the presence of MNEs in the same industry combined with in-house intangible capital leads to a 25.7% rise in TFP of domestic firms. Coefficients of forward $VF_{jt-1}$ and backward spillovers $VB_{jt-1}$ remain practically unchanged (negative and positive, respectively) albeit slightly lower in absolute terms compared to estimates in Table 3. The finding that horizontal spillovers are conditional on the level of in-house investment in intangible capital accords well with a stylised fact of the productivity convergence literature (Griffith et al., 2004) that stresses the dual role of internal investment in innovation. That is, investment in intangible

[27] The term technological profile here indicates industry's own efforts to devote resources for innovation.

[28] Another strand of the existing literature links spillovers to the strategy of MNE subsidiaries (Ha and Giroud, 2015). Accordingly, the type of innovation activity from MNEs determines the scope of productivity gains for local firms. Evidence from South Korean firms shows that competence–creating MNEs rather than competence-exploiting MNEs are those that generate substantial horizontal and vertical spillovers.

[29] The composite effect from horizontal spillovers is: $\frac{\partial \ln TFP_{ijt}}{\partial H_{ijt-1}} = \hat{\beta}_H + \hat{\beta}_{H\times INTA} \times INTA_{ijt-1} = 0.429 \times INTA_{ijt-1}$.

Setting the statistically insignificant coefficient $\hat{\beta}_H$ equal to zero and evaluating $INTA_{ijt-1}$ in its sample mean, we obtain the value of 2.57.

capital increases the internal technological capabilities of the firm, while it also eases the adoption of technological advancements already in use somewhere else.

### 3.3.2 Vertical Forward Spillovers: The Role of Direct linkages and Customized Inputs

Next, we elaborate on the negative value of forward spillovers, $VF_{jt-1}$, reported in Table 3. The spillover variable defined in (3) is based on an input-output coefficient that measures the amount that industry *j* consumes from the output of upstream industry *h*. However, it does not account for any specific relationship between domestic firm *i* and MNE *F* supplier in the upstream industry. This might be a serious omission that does not take into account structural characteristics of domestic firms in downstream sectors. The firm-level characteristic that is of particular importance here is the scope of product differentiation and the role of direct contacts with MNE suppliers that provide technologically advanced inputs of higher quality (Grossman and Helpman, 1991). Forward spillovers benefit domestic firms that directly purchase intermediate inputs from foreign subsidiaries but also through imitation for domestic firms that do not maintain direct contacts with foreign suppliers (Newman et al, 2015). A necessary condition for the realization of forward spillovers might be the existence of a sufficient number of domestic firms that are supplied by MNEs in upstream sectors. Subsequently, forward spillovers could be an increasing function of the number of domestic firms that use MNEs as input suppliers. Subsequently, forward spillovers are an increasing function of the number of domestic firms with MNEs as input suppliers. Furthermore, the purchase of technologically advanced inputs from MNE subsidiaries indicates that domestic firms have a substantial scope for product differentiation (Andresson et al. 2002). Domestic firms that attempt to differentiate the attributes of their products purchase customized inputs tailored to specific needs. Customized inputs are technologically intensive, while their use is systematically associated with a strategic tendency to upgrade product characteristics (Caselli, 2018). Overall, the use of customized inputs as a channel of product differentiation enhances productivity through the amount of tacit knowledge embodied in these inputs (Bas and Strauss-Khan, 2014; Bournakis et al., 2018). To sum up previous discussion, forward spillovers can be positive under two conditions: first, there are sufficient domestic firms in the downstream industry that use MNE subsidiaries in upstream sectors as suppliers and second, there are sufficient domestic firms that purchase intermediate inputs customized to specific product characteristics. Accordingly, we modify vertical forward ($MVF_{jt}$) spillovers in (3) as follows:

$$MVF^{d}_{jt} = \sum_{i=1}^{I} n^{d} \sum_{j \neq h}^{J-1} \gamma_{jh} H_{ht} \quad \text{with } i \in j \tag{7.1}$$

$$MVF^{q}_{jt} = \sum_{i=1}^{I} n^{q} \sum_{j \neq h}^{J-1} \gamma_{jh} H_{ht} \quad \text{with } i \in j \tag{7.2}$$

where $n^d$ is the number of firms in industry $j$ that directly purchase goods or intermediate inputs from foreign subsidiaries in upstream sectors and $n^q$ is the number of firms in industry $j$ that use customized intermediate inputs. We re-estimate specification (6) with modified vertical spillovers of (7.1) and (7.2) as explanatory variables. Coefficient estimates of both *MVF* indices are positive and statistically significant (Table 5). In columns 1-3, coefficients $MVF^{d}_{jt-1}$ and $VB_{jt-1}$ are in the range of 0.1 to 0.134%. In estimates of columns 4-6 they are slightly lower, albeit statistically significant at conventional levels. Such coefficient estimates indicate the importance of product differentiation and business ties with MNEs suppliers, which can make the size of forward spillovers (0.134 in wholly owned MNEs) twice as much as the average size found in the literature (Havranek and Irsova, 2011).

[Table 5 here]

### 3.3.3 Regional versus Non-Regional Spillovers

In this sub-section, we perform a final test for the exploration of horizontal spillovers by focusing on their spatial element and the potential of agglomeration knowledge spillovers in geographically concentrated areas. Geographical proximity allows for higher levels of labour mobility as well as it stimulates knowledge transfer via face-to-face communication of managers (Halpern and Muraközy, 2007; Xu and Sheng, 2012). Another stream of the literature of economic geography suggests that knowledge externalities are transmitted more effectively within small distances (Crespo et al., 2009). However, adverse competition effects are also possible in areas where domestic firms are geographically closed to MNEs. Nevertheless, in highly integrated product markets competition effects are expected to be independent from geographical distance with knowledge spillovers to dominate (Taylor and Taylor, 2004). We scrutinize empirically this hypothesis by constructing regionally based horizontal spillovers. We decompose the index of Horizontal spillovers in equation (2) into a regional and a non-regional part. The component of regional horizontal spillovers (*RH*) from MNEs located within the same NUTS2 regions is:

$$RH_{jt} = \sum\nolimits_{F \in j,k} s_{Fjkt} TFP_{Fjkt} \tag{8}$$

where *k* indexes region and *s* is now defined as $s_{Fjkt} = \frac{\sum_{F \in j,k} S_{Fjkt}}{\sum_{i \in j,k} S_{ijkt}}$.This is the share of sales of all MNEs *F* in industry *j* in region *k* to total sales in industry *j* in region *k* (country index is again suppressed for readability). As index (2) is the sum of regional and non-regional horizontal spillovers in industry *j*, the non-regional component of horizontal spillovers ( $NRH_{jt}$ ) is: $NRH_{jt} \equiv H_{jt} - RH_{jt}$ . Table 6 reports estimates of specification (6) that encompasses regional horizontal spillovers (*RH*) and non-regional horizontal spillovers (*NRH*) interacted with *INTA*. The coefficients of $RH_{jt-1}$ and $NRH_{jt-1}$ are insignificant in all definitions of foreign ownership. Interestingly, the highest in magnitude spillover effect arises from the interaction term of $RH_{jt-1} \times INTA_{ijt-1}$ under the MNE10 definition of foreign ownership. We calculate the semi-elasticity of $RH_{jt-1}$ as: $\frac{\partial \ln TFP_{ijt}}{\partial RH_{ijt-1}} = \hat{\beta}_{RH} + \hat{\beta}_{RH \times INTA} \times \overline{INTA}_{ijt-1} = 6.12.$ Accordingly, a 10% increase in regional horizontal spillovers increases TFP of domestic firms located within the same region by 61.2%. In MNE50 and MNE100 definitions, horizontal spillovers are also

economically significant. The relatively higher elasticity of *RH* in MNE10 definition indicates that collaborative projects between domestic firms and MNE subsidiaries is an important source of productivity gains for purely domestic firms that are located nearby. Our results suggest that the elimination of geographical proximity combined with absorptive capacity makes domestic firms instantly more receptive to the advanced technological know-how of foreign firms (Ju et al., 2013; Cheung and Ping, 2004).

[Insert Table 6]

### 3.4 Evaluating Knowledge Agglomeration Gains: Further Considerations

Table 7 shows the size of AG (the sum of elasticities) under the different determinants as presented throughout the paper. First, the economic value of AG without controlling for any other condition remains economically insignificant (despite statistical significance) and lower than 0.1. Accordingly, a 10% increase in wholly owned MNEs in the host economy (same industry, upstream and downstream industries) does not increase TFP of domestic firms more than 0.63% the maximum. The degree of ownership matters for horizontal spillovers. Contrary to recent evidence (Abraham et al. 2010; Javorcik and Spatareanu, 2008) that domestic firms learn easier from foreign firms if there are joint ventures of foreign firms and other domestic firms, we show that the wholly owned MNEs subsidiaries generate more significant horizontal spillovers at least in statistical terms. Our findings about horizontal spillovers are consistent with McCaughey et al. (2018) that also examine a large sample of EU firms. The greater size of horizontal spillovers from wholly owned MNE subsidiaries is associated with how subsidiaries respond to the liability of foreignness. Parental firms not only transfer important proprietary assets to the subsidiary but also majority and wholly owned subsidiaries are more likely to be "competence-creating" rather "competence-exploiting" subsidiaries (Ha and Giroud, 2015). To defend and maintain competence MNEs need to source from domestic partners, which increases the potential of spillovers (Cantwell and Mudambi, 2005; Narula, 2014; Papanastassiou et al., 2019).

We attribute the economically weak AG to the fact that EU firms are already closed to technological frontier with a small technological gap between domestic firms and MNES thus limited potential for knowledge spillovers. The latter are an increasing function of technology gap between domestic and foreign firms (Meyer and Sinani, 2009). Economically important spillovers from MNEs can still flow if domestic firms have the appropriate level of absorptive capacity. The size of these gains for domestic TFP can be as close as to 26% after a 10 percent increase in the presence of wholly owned MNEs as shown in Table 7. The literature usually refers to absorptive capacity in terms of human capital (Narula and Marin, 2003), in our study substantial gains are generated from intangible capital. This finding essentially unveils differences in intangible capital intensity even among developed countries. Indicatively, France has the highest ratio of intangible capital 7% in our sample, while UK firms spend on average 2.1%. Insufficient investment in factors driving innovation is regarded a key reason for the UK productivity slowdown in the last fifteen years (Bournakis and Mallick, 2018).

The size of backward spillovers is economically meaningful without accounting for any other condition. This highlights that foreign subsidiaries have already developed strong ties with local supplies, more likely due to high technological similarity between domestic EU firms and MNEs. Local suppliers in EU countries can easily comply with the quality standards of investors, which increases the intensity of linkages thus greater potential for knowledge transfer. Finally, domestic firms demonstrate structural heterogeneity in terms of strategic orientation and motives that matter for forward spillovers. The latter become significant if domestic firms use directly foreign firms as suppliers but to do so they must also have a scope for product differentiation and need of customized inputs.

[Insert Table 7]

## 4. Identification Strategy to address Endogeneity and Measurement Bias

### 4.1 FDI Restrictiveness and Changes in the EU Services Policy Regime

Estimates reported in Tables 2-6 search for horizontal and vertical FDI spillovers controlling for absorptive capacity, firm characteristics and geographical proximity. Nonetheless, results might be biased due to unobserved reverse causality between domestic TFP and spillover indices, $H_{jt}$, $VF_{jt}$ and $VB_{jt}$. Location decisions of MNEs' are usually driven by characteristics of host markets. For example, MNEs select locations where domestic firms are highly productive, skilled labor abundant, while there consumer and supplier networks are also well-established. Another source of bias in estimating equation (6) emerges from omitted variables that are jointly related to TFP and spillovers. The standard approach for addressing endogeneity bias in (6) is to use an Instrumental Variable (IV) estimator. In firm level studies, the identification of valid firm specific instruments that will be correlated with the endogenous variables and uncorrelated with the error term is an extremely difficult task. Weak instruments in two stages least square estimations induces bias that in cases exceeds OLS bias (Murray, 2006). In two stages least square and equivalently GMM estimators, the Wald test is also severely distorted due to weak instrumentation making hypothesis testing and statistical inference problematic (Bun and Windmeijer, 2010). The shortcomings existing in two stages least square estimations make imperative the use of an alternative methodology for mitigating endogeneity.

To establish a causal relationship between spillovers and TFP of domestic firms, we first identify exogenous sources of variation that are associated with horizontal and vertical spillovers. In doing so, we rely on two pieces of information: a) the evolution of the FDI restrictiveness index and b) the timing of the European Union (EU) Services Liberalization Directive initiated in the end of 2006. These two regulatory policy changes are not plausibly caused by firm level TFP and could be used to identify MNEs' spillovers.[30]After establishing correlation between the two exogenous instruments and spillover variables $H_{jt}$, $VF_{jt}$,

[30] We could not use these two factors as instruments in a 2SLS IV estimation as these two variables are only time variant across countries without firm or industry level variation. This feature makes them by default weak instruments in a 2SLS estimation inducing the problems of weak instrumentation already discussed above. Nonetheless, these two events are highly appropriate for the dif-in-dif approach that we have chosen to use instead.

$MVF_{jt}^{d}$, $MVF_{jt}^{q}$ and $VB_{jt}$, we examine if TFP of domestic firms increased in countries that relaxed FDI restrictions after the EU Services' Liberalization Directive in 2006.[31]

We first explore whether these two regulatory regime changes are related to horizontal and vertical spillovers. EU services liberalization and FDI restrictions determine a country's profile as a destination for foreign investors. Accordingly, spillovers originating from MNEs are also driven by the timing of EU Services liberalization and the extent of restrictions on foreign investment. Appendix A9 shows the evolution of the FDI regulatory restrictions across the six countries of our sample. Hungary, Italy, Spain and UK relaxed their FDI restrictions straight after the introduction of the EU Services' Liberalization Directive in 2006, while France and Germany did not implement any change after this year.

To examine if FDI restrictions and liberalization of services affect spillovers, we introduce the following econometric specification:

$$SPILL_{jt} = \gamma_0 + \gamma_1 FDI_t + \gamma_2 T_t + \theta_c + \eta_j + \nu_t + \varepsilon_{jct},$$
$$\text{with} \quad Spill \in \left\{ H_{jt}, VF_{jt}, MVF_{jt}^{d}, MVF_{jt}^{q}, VB_{jt} \right\} \qquad (9)$$

The dependent variable of equation (9) is the spillover (*SPILL*) index in country *c* (suppressed for readability), industry *j* in year *t*. We only consider spillovers from the MNE100 definition, which provide systematically the most statistically and economically higher coefficients in Table 3. *FDI* is a dummy variable taking the value of 1 if a relaxation in FDI restrictions took place in country *c* after 2006 and zero, otherwise. We include in (9) a time dummy *T* which receives ones from 2007 onwards, after the implementation of the EU Services Liberalization Directive. The time fixed effects $\nu_t$ are also included to capture among others the effect of the 2007-2009 global financial crisis. Specification (9) is also augmented with industry $\eta_j$ and country fixed ($\theta_c$) effects. OLS estimates in Table 8 confirm a positive and statistically significant correlation between relaxation in FDI restrictions and spillover indices, $SPILL_{jt}$. The effect of the time dummy *T* on spillover variables is less certain. It is positively associated with $H_{jt}$ but negatively with $VF_{jt}$, $MVF_{jt}^{d}$, $MVF_{jt}^{q}$ and $VB_{jt}$.

[Insert Table 8]

[31] The implementation of the EU Services' directive was a long process with some countries (more reluctant to services liberalisation) postponing the adoption of the directive after 2006.

4.2 Difference in differences estimates

Having demonstrated a strong relationship between spillovers and policy instruments, we use a difference in differences (dif-in-dif) specification to examine if there is a causal effect of spillovers on TFP of domestic firms. We compare TFP in the treatment group (firms in countries that relaxed FDI restrictions after the 2006 Services Liberalization Directive) with TFP in the control group (firms in countries that did not relax FDI restrictions after 2006). In other words, we observe pairs of firms and countries before and after the policy change. The control group, essentially, includes firms from France and Germany, the countries that did not relax FDI restrictions after 2006, while the treatment group includes firms from Italy, Spain, UK and Hungary. To compare TFP differences between firms of the two groups, we estimate the following dif-in-dif specification:

$$\ln TFP_{ict} = \delta_0 + \delta_1 Q_{ct} + \delta_2 I(T > W) \; + \delta_3 Q_{ct} \times I(T > W) + \delta_4 X_{ict} \qquad (10)$$

$Q$ is a dummy variable taking the value of 1 if we observe a negative change in the FDI regulatory burden in country $c$ and zero otherwise, $I(T>W)$ is an indicator function equal to 1 if the period is after the policy change (2007 onwards) and zero otherwise. $Q_{ct} \times I(T > W)$ is an interaction term that captures the impact of lower FDI restrictions on TFP after EU Services Liberalization. Parameter $\delta_3$ is the dif-in-dif estimate representing the TFP impact of lower restrictions on FDI after liberalization of EU Services. Vector $X$ includes $CR_{jt}$, $LEV_{ijt}$, $INTA_{ijt}$, $SME_i$, $AGE_i$ and $Export_i$ that influence TFP either through their association with $Q$ or $I(T>W)$. Specification (10) includes industry, country and time fixed effects.[32]

[Insert Table 9]

The upper panel of Table 9 displays estimates of TFP for both treated and control firms before the liberalization of EU services in 2006. It also reports estimated TFP differences between the two groups along with their associated standard errors. The difference in TFP is negative and statistically significant meaning that firms in countries that did not relax FDI restrictions (France and Germany) achieved higher TFP vis-à-vis firms in countries that did (UK, Italy, Spain, Hungary). The lower panel of Table 9 reports estimates of TFP for treated

[32] Coefficient estimates of covariates in $X$ are not reported.

and control firms for the post-2006 EU Services Liberalization Directive. The difference in TFP between treated and control firms is also negative for the post 2006 period. The dif-in-dif estimate that represents the policy effect is 0.104 in Column 1. This finding suggests that, contrary to the control group, firms in countries that relaxed FDI restrictions achieved a relatively higher TFP after the announcement of the policy change. Our dif-in-dif specification also explores whether the policy effect varies across quantiles of the TFP distribution.

Since the classification of firms into treatment and control groups is not random, unobserved factors might bias the estimation of the treatment effect. To reduce selection bias, we use propensity score matching based on specific characteristics that could determine selection into treatment and control groups. We match observations using $CR_{jt}$, $LEV_{ijt}$, $INTA_{ijt}$, $SME_i$, $AGE_i$ and $Export_i$. The dif-in-dif estimate after matching observations remains positive in column 6 (Table 9) showing that firms in countries that relaxed FDI restrictions achieved higher TFP vis-à-vis those in counties that did not. The economic size of this effect (0.082) is also significant as it represents 12% of the average TFP score (0.682) of treated firms before the policy change.

Finally, a long negotiating process among EU members was preceded the EU Services Liberalization in 2006. Policy effects in Table 8 might represent precautionary action of economic agents in anticipation of deregulation in EU Services. If policy effects were anticipated, then we are likely to obtain lower-bound estimates of the true effect partly because some effects occurred before actual policy implementation. The first political signal on the forthcoming EU services liberalization was given in early 2004 when the European Commission announced the Internal Market Services Directive. We use this as a cut-off year to compare TFP between treated and control firms in Table 10. We replicate estimates of Table 9 based on the same set of control variables. Estimates of the first two columns confirm that even if liberalization had been anticipated, firm-level TFP in countries that relaxed FDI restrictions improved well before the official adoption of the EU Services Directive in 2006.

The remaining estimates of Table 10 (columns 3-6) present placebo estimates based on a false timing of the liberalization of EU Services. Precisely, we consider 2003 (columns 3-4) and 2002 (columns 5-6) as wrong dates of FDI services liberalisation. The dif-in-dif estimates for both years are either insignificant (column 4) or negative (column 3). Gathering evidence from Table 10, there is no positive effect on TFP prior to the initial announcement of 2004, suggesting that any improvements in productivity took place only after the original announcement of liberalization in 2004. These sensitivity tests enhance further the reliability of the estimated effect of FDI services liberalisation on TFP.

[Insert Table 10]

Overall, the sensitivity analysis in section 4 show that a considerable decrease of the TFP gap between control and treated firms emerged only after the introduction of the EU Services Liberalization Directive in 2006 in countries that actually relaxed FDI restrictions. As both EU Services Liberalization Directive and relaxation of FDI restrictions are significantly associated with spillover indices (Table 8), our estimates in Tables 3 to 6 are robust and fairly prove that spillovers generated from MNE100 exert a positive causal effect on TFP of domestic firms.

## 5. Concluding Remarks

In this paper, we revisit the puzzle regarding the role of MNEs spillovers on performance of domestic firms. We distinguish between market share effects and knowledge Agglomeration gains. Accordingly, we regress measures of foreign presence on mark-ups and TFP of domestic firms. We have derived a measure of physical TFP that separates changes of technological progress from price effects. Using a sample of manufacturing firms form six EU countries, we found that higher presence of MNEs decrease the mark-up charged by domestic firms. The value of the MS effect is close to two percent and signifies welfare gains for consumer of the host economy. We further investigated whether the value of knowledge spillovers from MNEs varies with the degree of foreign ownership. We found that under strict definitions of majority and full-foreign ownership the value of horizontal spillovers is higher. Nonetheless, the value of this effect remains economically negligible. When we control for absorptive capacity, in the form of intangible capital the economic size of horizontal spillovers increases considerably. Furthermore, domestic firms that are geographically close to MNE subsidiaries and invest in intangible capital can more easily benefit from knowledge spillovers. Backward spillovers from MNEs in downstream industries are also important, nonetheless forward spillovers from upstream industries are not straightforward. Our empirical analysis has shown that domestic firms benefit from the presence of MNEs in upstream industries only if they purchase inputs directly from they and they have substantial scope for product differentiation as reflected in the use of customised inputs. A key message from our analysis is that intangible capital in benefiting from MNE related spillovers is of prominent importance. A relevant policy recommendation derived from the analysis is that domestic firms should be provided with targeted incentives for boosting internal innovative capabilities as this will help them to develop more effective synergies and interactions with the technological capabilities of MNE subsidiaries.

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