Equity Control and FDI Spillovers

By

Lisbeth la Cour, Sara L. McGaughey and Pascalis Raimondos

February 27, 2018

Abstract: The FDI productivity spillover literature usually identifies a firm as foreign by the so-called IMF definition, viz. a 10% *direct* foreign ownership threshold. This definition emphasizes influence and dates back to the post WWII era. The reality, however, nowadays is different as firms are owned through a series of *indirect* links that hide the true ownership structure. In this paper we adopt the 50% ultimate foreign ownership definition that emphasizes control. One could think that such a shift from 'influence' to 'control' would lead to fewer foreign firms. However, as this paper shows, this is not the case. We find double as many firms being foreign using the ultimate ownership definition compared to using the IMF definition. Moreover, these foreign-controlled firms, turn out to be the most productive firms in our dataset. The implication of this is pivotal when measuring FDI productivity spillover effects: while we find no horizontal spillover effects by using the standard IMF definition of what is "foreign", we find positive and significant horizontal spillover effects when using the ultimate owner definition.

JEL Codes: F23, D24.
Keywords: Foreign direct investment, direct vs. ultimate owner, productivity spillovers.

Authors Affiliations: La Cour: Copenhagen Business School. McGaughey: Griffith University. Raimondos: QUT, CEPR, and CESifo.

Corresponding Author: Pascalis Raimondos, School of Economics and Finance, QUT, 2 George st., Gardens Point, 4000 Brisbane, Australia (pascalis.raimondos@qut.edu.au)

Acknowledgments: We would like to acknowledge Federico Clementi for his comments in the initial phase of this paper. We also thank seminar participants at Chuo, Hitotsubashi, QUT, Griffith, and Adelaide universities and conference audiences at the Australasian Trade Workshop 2017, the World Bank/CEPR 2017 conference on GVCs, and the European Trade Study Group 2017. Mette Frank, Natalie Kessler, Jacek Przybyszewski, Emilie Helberg Pedersen, and Astrid Vibe-Pedersen provided excellent research assistance. The research was supported by a grant from the Danish Research Council (DFF 4003-00004).

1. Introduction

To what extent the presence of foreign firms can create positive 'spillovers' that boost the productivity of domestic firms is a question of enduring interest among scholars of strategic management, international business, and economics alike. The presence of foreign firms creates opportunities for domestic firms to access and learn about a diversity of new technologies and managerial know-how (Fu 2012; Spencer 2008; Zhang et al. 2014; Zhang et al. 2010). The 'fresh winds of competition' accompanying foreign direct investment (FDI) may also foster innovation and an upgrading of local firms' productivity (Aitkin and Harrison 1999; Chang and Xu 2008; Eden, 2009). Governments worldwide remain keen to attract and facilitate foreign direct investment (UNCTAD, 2017), in part to secure such spillovers to domestic firms.

Measuring productivity spillover effects from the presence of foreign firms is, however, not an easy task. There is an emerging consensus based on robust empirical evidence that positive spillovers are found in vertical relationships between foreign affiliates and their domestic suppliers (Javorcik 2004, Javorcik and Spatareanu, 2011). In contrast, empirical studies on horizontal or intra-industry spillovers (i.e. from foreign firms to domestic competitors) show mixed results. While some show positive spillover effects (Haskel et al. 2007; Zhang et al. 2010), most confirm the absence of positive horizontal spillovers, or even negative effects (e.g. Aitkin and Harrison 1999; Altomonte and Pennings 2009; Javorcik 2004; Girma et al. 2015; Lu et al. 2017). A variety of explanations have been put forward for these divergent results (e.g. different industry, country and firm level characteristics, changing spillover effects over time, etc). In our study, we step back and ask a more fundamental question that underlies all studies of FDI-induced spillovers.

What is 'foreign' in our complex and interdependent world? How might different definitions of FDI affect the extent to which we can identify productivity spillovers from the presence of foreign firms? Addressing these questions is where the major contribution of our paper lies.

The most widely used definition of a FDI involves a single foreign investor directly owning at least ten per cent (10%) of shares in a company, with the purpose of gaining an effective voice in its management. In contrast to this definition based the foreign investor's influence in decision making, we argue that control – based on more than fifty per cent (50%) ownership of an affiliate, or 'ultimate ownership' – is more relevant for generating FDI-induced productivity spillovers. Ownership confers both the rights of control (or residual powers) over how owned assets will be used, and rights to the residual income from the asset (Hart 1995, 2017). The security this ultimate ownership affords encourages the parent to exchange knowledge and technology with an affiliate at a much higher level than any couple of firms with no controlled relationship. If control does matters in this way, then the possible spillover effect from foreign affiliates to domestic firms will be affected by what definition we use to categorize a firm as 'foreign'.

Importantly, such control can be attained through both direct and indirect ownership links. The endemic use of direct ownership linkages in the FDI-induced spillover literature – whatever the threshold of

ownership applied – fails to capture the nature of our globalising world. Indirect ownership structures are ever more common. Large multinational enterprises (MNEs) increasingly utilize detailed and complicated ownership structures, sometimes seeking to hide direct ownership patterns for tax and financial reasons (Allred, Findley, Nielsen and Sharman, 2017). Complexity in MNE structures is further driven by the increasing growth and fragmentation of production that results in MNEs constantly reconfiguring their international value chains (Beugelsdijk, Pedersen, and Petersen, 2009; Mudambi and Venzin, 2010), and by modalities of growth such as mergers and acquisitions, joint ventures and alliances between firms (UNCTAD, 2016). The ownership structure of some MNEs is thus characterised by considerable vertical depth – that is, multiple steps from the ultimate owner to affiliate, often across multiple borders. Indeed, the 2016 World Investment Report (UNCTAD, 2016) documents how around 41 per cent of foreign affiliates worldwide are ultimately owned by their corporate parent through a chain of ownership in which at least one intermediate affiliate is based in a country different from the ultimate owner. Who is the ultimate owner can thus be non-obvious. To identify ultimate ownership, one needs a multi-country firm-level data set with information about the ownership structure of firms. Data constraints have meant that past empirical studies of FDI-induced productivity spillovers rely almost exclusively on direct ownership measures of FDI.

We use the ORBIS dataset of all European firms and their time-variant ownership pattern to create a consistent unbalanced firm-level panel dataset for approximately 2.5 million manufacturing firms over 2001-2008, and pay careful attention to how firms are categorised. Specifically, we define 'foreign firms' using both the 10% direct ownership by a single foreign entity definition (i.e. influence-based) and the 50% ultimate ownership definition (i.e. control-based). Unlike prior studies, we further distinguish between direct and indirect ultimate ownership. We also separate domestic MNEs from pure domestic firms. In measuring productivity spillovers we use total factor productivity, and adopt the control function approach developed in Ackerberg et al. (2006, 2015) and applied in De Loecker and Warzynski (2012) and De Loecker et.al (2016). This approach is careful in dealing with the endogeneity of inputs problem that exists when calculating the residual of the output minus inputs component of productivity. Our empirical strategy involves running FDI productivity spillover regressions on different firm sets and comparing the results.

Our findings are surprising. Intuitively, one might expect that the definition with a low threshold of 10% foreign direct investment would pick up more foreign firms than the 50% definition. However, we find the opposite: there are double as many firms that are ultimately controlled than what the 10% definition captures. These foreign controlled firms turn out to be on average larger (employ more capital, labour, and materials) and more productive than the 10% foreign firms. This implies that within this set of controlled firms there is substantial subset of firms that is not captured by the direct 10% set of firms because they are controlled by only indirect ownership links. These indirectly controlled firms are found to be the most productive of all. Running FDI spillover regressions using the 10% definition of FDI, we

find positive effects that weaken and eventually disappear as more control variables are added. This is consistent with prior studies. In contrast, when we run regressions using the 50% definition of foreign firms, we find positive and robust spillover effects. Moreover, there are indications that these effects are even stronger when we consider only the indirectly controlled firms. Overall it seems that taking into account the importance of control and the complexities of MNE ownership linkages characteristic of our modern world has a significant impact on identifying positive horizontal spillover effects. Our study contributes to the strategy literature by showing that more productivity spillovers from FDI to domestic firms within the same industry may occur than previously thought. This also holds significant policy implications for the attractiveness of FDI.

We present our study in four sections. The next section lays the historical context and theoretical foundations for our novel categorisation of 'foreign' and 'domestic' firms, and problematizes the FDI-induced spillover literature in this regard. We then describe our data and methods, followed by our results and supplementary analyses. We conclude with a discussion of our main findings and implications for future research.

2. Theoretical and empirical background

In this section we map the historical development of what is 'foreign direct investment'. This provides important context for our categorisation of firms, and subsequent problematisation of the FDI-induced spillover literature. We provide a short review of the literature on spillovers, and explain where our own contribution lies.

2.1. Defining Foreign Direct Investment. The International Monetary Fund provided one of the earliest and most enduring attempts at proposing and refining the definition of foreign direct investment in the post war era through its Balance of Payments Manual. In particular, an emphasis on control was explicit in definitions provided in the early editions of the Manual 5 (BPM1 1948, BPM2 1950). For example, the very first edition (IMF 1948, p. 47) defined foreign direct investment as comprising: (a) an enterprise in country Y which is a branch of an enterprise in country X; or (b) an enterprise in country Y that is a subsidiary of an enterprise in X – i.e. it is incorporated in Y but effectively controlled by residents in X – where control is inferred if 50% or more of voting stock is controlled by residents of X, or 25% or more of voting stock is concentrated in the hands of a single holder or organised group of holders in X, or a resident of X has a controlling voice in its policies; or (c) commercial real estate in Y owned by residents of X. The first edition even hinted at more complex ownership structures: "A direct investment may be owned by two or more countries jointly; similarly, a direct investment in Y may be owned by an enterprise in X which itself us a direct investment of an enterprise in Z (or even Y) (IMF 1948, p. 47). This definition remained in the second edition of 1950.

Elaborating on the notion of foreign direct investment, the third edition of the IMF Balance of Payments Manual (BPM3) (1961) defines [foreign] direct investment as "investment made to create or

expand some kind of permanent interest in an enterprise: it implies a degree of *control* [emphasis added] over its management. [. . .] It is characteristic of direct investment that the investor possesses managerial control over the enterprise in which the investment is made and he [sic] also makes available to it his technical knowledge (know-how)" (IMF 1961, p. 118). Direct investment continued to be distinguished from portfolio investment, where the investor "has no intention of playing a major role in the direction of policies of the enterprise." There emerged, however, considerable definitional ambiguity. The "exercise of an important voice" was used interchangeable with "direct control" (p. 120). Further, the third edition stated that it was not "desirable to give a rigid definition of the concept of the direct investment enterprise" and that "specific percentages suggested for determining whether a given enterprise is to be classified as a direct investment enterprise should be regarded as no more than rules of thumb" (p. 119). By the fourth edition, the foreign direct investor's purpose was to "have an effective voice [emphasis added] in the management of the enterprise" (IMF 1977, p. 128, 136).

The fourth edition included a survey of member country concepts and practices concerning direct investment flows, undertaken by IMF staff. Diverse practices among countries showed accepted evidence of FDI to range from 25 to 10 per cent foreign ownership, with a tendency to the low side (IMF 1977, p.137). The survey also explicitly asked about indirect ownership whereby a foreign investor could exert an 'indirect voice' in the resident enterprise (p. 189). Indirect investment was not commonly considered by respondents at the time, with the direct ownership link typically being the only link registered in a country's national statistics. Nonetheless, the subsequent fifth edition (IMF 1993) for the first time defined a direct investment enterprise as one in which a direct investor, who is resident in another economy, owns 10% or more of the ordinary shares or voting power (or equivalent). It also made explicit that a direct investment enterprise is either directly or indirectly owned by the direct investor (IMF 1993, p.86). This definition has been retained in the sixth and latest edition of the Manual (IMF 2009, p. 101), which was conducted in parallel with the OECD Benchmark Definition of Foreign Direct Investment and the System of National Accounts to maintain and enhance consistency between the three important standards.

Two aspects of the evolution in these definitions of FDI stand out. First, whereas the initial emphasis was on effective control with somewhat higher percentages of foreign ownership required to signify foreign direct investment, a shift towards influence or an important voice was evident from at least BPM3 in 1961. Related, a much lower threshold for ownership was reported in country practices in BPM4 (IMF 1977), with the minimum threshold of ownership being reduced to ten per cent (10%) in the BPM5 (IMF 1993) definitions. Second, in contrast to the early emphasis on direct ownership links, indirect ownership by a foreign direct investor was explicitly included in the definition of a direct investment enterprise as recently as BPM5.

On what aspects of the IMF definition empirical researchers will focus is, of course, dependent on the question at hand. For example, in the public finance literature on profit shifting, a foreign affiliate is empirically identified by whether there exists an owner that controls 50% of the firm's shares; see among

others Huizinga and Laeven (2006) and Dharmapala and Riedel (2013). Such a control may not only be exercised through direct ownership links but also through indirect ownership links. By combining the direct and the indirect ownership links the concept of ultimate ownership (UO) arises. Such a concept is directly linked to the independence of a firm. If the firm is independent it will have no ultimate owner, and vice versa. The distinction between direct and ultimate ownership is illustrated in Figure 1.

Figure 1: Direct vs Ultimate ownership

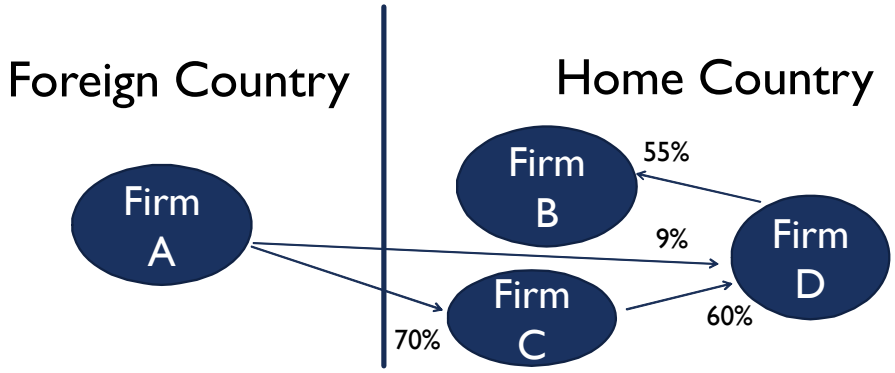


Figure 1 depicts two countries, 'home' and 'foreign'. In the home country firms B, C and D are connected through ownership links. In the foreign country, firm A in the foreign country has some direct ownership to two of the three firms in the home country. It is easy to see that firm A controls directly firm C by owning more than 50% of its shares. Thus, firm C will be categorised as foreign when using either the 50% ultimate owner definition (hereafter $FDI50$) or the 10% direct owner definition (hereafter $FDI10$) of what is a foreign firm. Under the $FDI10$ definition, firms B and D will be categorised as domestic because the direct ownership links used in $FDI10$ show a domestic owner (the legal address of firms B and D is domestic). However, using the ultimate ownership definition of what is foreign gives a different picture. All three firms B, C and D are controlled by firm A by direct and indirect ownership links. Hence, firm A is the ultimate owner of all domestically operating firms in the above example. Knowing the complete (direct and indirect) ownership tree of a firm will also help us identify whether a domestic firm is the ultimate owner of firms in other countries — that is, a domestic MNE (named here $MNE50$).

The magnitude of ultimately owned foreign firms in domestic economies that are not captured by the $FDI10$ definition – and thereby treated as domestic firms – is highlighted by recent analyses reported in the United Nations World Investment Report 2016 (UNCTAD, 2016). The report documents that around 55% of foreign affiliates are not directly owned by their ultimate owner. More than more than 10% of all foreign affiliates are owned through an intermediate entity in a third country, while more than 30% are indirectly ultimately owned through a domestic entity. Under definitions of FDI that rely on direct ownership to the neglect of indirect ownership, this latter group will be classified as 'domestic'.

More specifically, a seemingly domestic firm under the IMF 10% direct foreign ownership definition may conceivably be controlled by a foreign entity through series of ownership linkages, with no direct ownership of the local affiliate whatsoever (UNCTAD, 2016).

We turn now to the spillover literature to better understand the extent and implications of such misclassification.

2.2. Productivity Spillovers. Productivity spillovers — often called technological spillovers — are informal, involuntary, non-market transfers in which the activities of one firm affect the productivity of another in ways that are not fully captured by the source firm (Eden, 2009). Foreign firms are typically more productive than their domestic competitors in the host country (Girma et al, 2015). Indeed, faced with a 'liability of foreignness' — or additional costs incurred in the foreign market above those experienced by domestic firms (Hymer 1960; Zaheer 1995; Helpman et al. 2004, Zhou and Guillen, 2016) — foreign entrants typically possess some compensatory firm-specific advantages (i.e. strengths relative to domestic rivals). This includes advantages that arise through multinationality, such as access to superior resources and capabilities (e.g. financial, technological, organisational) through the MNE network that are not readily available locally (Bartlett and Ghoshal, 1989; Rugman and Verbeke, 2001; Verbeke and Yuan, 2010; Zaheer, 1995). In turn, spillovers occur when the domestic firm learns about the new technologies, marketing or management techniques, products and strategies brought by the foreign affiliates operating in their industry (i.e. demonstration effects) or by hiring workers trained by foreign affiliates (i.e. labour market impacts), and in this way improve their performance (Blömstrom and Kokko, 1998). The 'fresh winds of competition' may also force host country firms to improve their efficiency and reduce their costs by, for example, updating manufacturing technologies, adopting advanced marketing and management techniques, or pursuing new strategies (Spencer, 2008). However, competition can also diminish the scale of operations of the host country firms as they lose market share to generally more productive foreign MNEs (i.e. market stealing), and thereby lead to negative productivity effects (Aitken and Harrison, 1999). With the overall effect being theoretically ambiguous, numerous empirical studies have attempted to find and explain FDI-induced productivity spillovers.

Studies of FDI productivity spillovers began with a search for intra-industry spillovers. Early studies based largely on cross-sectional data sets generally found positive horizontal spillovers (e.g. Caves (1974) for Canada and Australia; Blömstrom and Persson (1983) for Mexico). Subsequent studies using panel data sets and controlling for industry fixed effects found negative or no effects for developing countries (e.g. Aitken and Harrison (1999) for Venezuela; Haddad and Harrison (1993) for Morrocco; Blalock and Gertler (2008) for Indonesia), and positive effects for developed countries (e.g. Keller and Yeaple (2009) for U.S. and Haskel et al. (2007) for U.K.) Conflicting results were attributed to great variability in empirical specifications and measures used for productivity (Sjöholm 1999; Smeets 2008) and observations that country and industry differences are at least as important in explaining disparate results as the econometric methods and measures used (Görg and Greenaway 2004).

Javorcik (2004) re-oriented the literature, arguing that scholars are looking in the wrong place for spillovers. With vertical FDI, and especially backward linkages or contacts between the MNE and local suppliers, the MNE has an incentive to improve the performance of the intermediate input suppliers.[1] Vertical backward spillovers are more prounounced when the venture is owned jointly by domestic and foreign entities (Havranek and Irsova, 2011; Javorcik, 2004; Newman et al., 2015). Javorcik (2004) argued that such ventures are more likely to source locally than wholly foreign owned entities, leading to greater spillovers. In contrast, with horizontal FDI MNE managers have an incentive to prevent technology leakage and other spillovers from taking place to the extent that the foreign affiliate is competing with domestic firms. Since then, the literature on horizontal spillovers has tried to identify under what conditions positive effects might exist, considering the absorptive capacity and motivation of domestic firms (Meyer and Sinani, 2009), the diversity of FDI country origins (Zhang et al., 2010), and the impact of time on spillover effects (Altomonte and Pennings 2008; Kosová, 2010; Liu, 2008), with continuing mixed results. Recent advances focus on better identifying the causal effect that FDI has on domestic firms. Girma et al. (2015) use statistical techniques to separate the direct from the indirect effect of the presence of foreign firms. Lu et al. (2017) exploit the staggared foreign investment liberalisation across Chinese industries as an instrument to carefully tease out the causal effect of FDI on domestic firms. Their results confirm previous studies where horizontal spillover effects are found negative and vertical spillover effects are found positive.

As mentioned in the introduction, we take a step back and question how we define firms as domestic or foreign in our globalised economy. Existent studies show great variability in definitions used with seemingly no common standard other than the use of direct ownership links.[2] For example, using data drawn from Venezuela's National Statistical Bureau, Aitken and Harrison (1999) were able to distinguish between firms with less than 20% direct foreign ownership, with 20% to 49.9%, and 50% or more. Javorcik (2004) and Lu et al. (2017) both use continuous variables of foreign direct ownership equity shares in their study of spillovers in Lithuania and China respectively. In contrast, using Romanian data extracted from ORBIS, Altomonte and Pennings (2009) considered a firm foreign if more than 10% of its shares directly belongs to an MNE, and domestic otherwise. Similarly, in a sample of firms in China, Girma et al (2015) deem a firm to have foreign ownership if foreign investment accounts for at least 10% of the firms' shares. Also using a sample in China, Chang and Xu (2008) use a 25% share of equity as the threshold for identifying a foreign firm, whereas Zhang et al. (2010) define foreign firms as 100% foreign-owned and domestic firms as 100% domestic owned.

The ultimate owner definition, that we advocate here because it takes into account both direct and indirect ownership links, is rarely used. Temouri et al. (2008) use the ultimate owner definition to

[1] Positive vertical spillovers may thus take place, for example, through direct knowledge transfer from the foreign affiliate to local suppliers, pressures from the MNE to improve product quality and efficiencies, or an increase in the demand for the intermediate inputs that allows local suppliers to achieve the benefits of scale economies.

[2] Indeed, we found a number of FDI-induced spillover studies where what constitutes FDI is not even remarked upon.

identify firm nationality in Germany but only in order to separate out the domestic MNEs. This is indeed important as domestic MNEs (e.g. Phillips in Holland) operate as any other MNE in global markets and are thus able to secure productivity enhancements through internal mechanisms (e.g. within-the-firm labour and technology markets) that can then spill over to other domestic firms. Any search for finding spillover effects from the presence of foreign firms should exclude such domestic MNEs from the set of domestic firms. However, despite having ultimate ownership data, Temouri et al. (2008) resort to defining a foreign firm using the IMF 10% minimum direct investment threshold. In contrast, Castellani and Zanfei's (2003) study of 3,932 firms across France, Italy and Spain does distinguish foreign-owned from domestic firms by using an ultimate owner definition, but does not compare the implications of using different definitions of FDI. Nor do they distinguish between direct and indirect linkages in ultimate ownership. In that sense, we do not know whether it is the definition of foreignness that explains their results or the particular dataset and methods they use.

In short, very few studies consider the importance of ultimate ownership – whether direct or indirect. The IMF operationalisation of foreign direct investment (i.e. what we call here $FDI10$) remains most common, and we know of no study that measures and compares spillover effects under different definitions of 'foreignness'.

2.3. Control, Ultimate Ownership and Expected Spillovers. Our expectation is that positive horizontal productivity spillovers are more likely to be found when using an ultimate owner definition (i.e. $FDI50$) to identify the presence of foreign firms in a domestic economy, than with the commonly used low threshold of 10% direct foreign ownership (i.e. $FDI10$). We advance two main reasons for this conjecture.

First, the liability of foreignness is likely to be for acute for a MNE when engaging in horizontal FDI and thereby competing directly with local firm, more so than with vertical FDI (Zaheer, 1995). This implies a strong need to transfer (as a minimum) compensatory firm specific advantages to the foreign affiliate. At the same time, horizontal FDI creates strong incentives for the MNE to prevent spillovers to competitor firms in the same industry (Javorcik, 2004). Thus, our conjecture is that control matters. That is, the MNE is only willing to transfer these high levels of knowledge and technology if it controls its affiliate. Ownership confers the rights of control over the foreign affiliate's assets: that is, the right to decide how the assets will be used, except to the extent that particular usages have been specified in any initial contract (Hart 1995, 2017; Hart and Moore, 1990). The ultimate owner can effectively implement key decisions and business activity of the foreign affiliate, deciding on matter such as new investments in plant and equipment, branding and marketing strategy, selection of suppliers, the use of firm-based or legal mechanisms to protect its proprietary knowledge, and incentives or sanctions to retain human capital with key knowledge and discourage opportunistic behaviour. Ownership also confers rights to the residual income from the assets of the foreign affiliate (Hart 1995, 2017) and the possibility to engage in organisational practices to maximise this residual, such as transfer pricing or profit shifting.

Overall, the security that ultimate ownership affords encourages the parent to exchange knowledge and technology with its foreign affiliate at a much higher level than any couple of firms with no controlled relationship. This creates the potential for spillovers — through demonstration effects, labour market impacts and competitive pressure on domestic firms to upgrade — in a way that a low threshold of foreign investment cannot. Anecdotal empirical evidence supports this view. For example, Nachum (2010) found that majority owned affiliates of foreign MNEs in London's financial sector had significantly more advantages than minority-owned affiliates, and interpreted this as reflecting the greater benefits that accrue to majority owned affiliates from the advantages of their parents. Zhang et al. (2014) similarly suggest that foreign partners in international joint ventures are more likely to contribute their technologies and skills if they have majority ownership. If control does matters in this way, then we expect that the possible spillover effect from foreign affiliates to domestic firms will be greater with the presence of ultimately owned foreign affiliates ($FDI50$) than with foreign firms defined under the lower and direct ownership threshold ($FDI10$).

Second is an issue of misclassification. The 10% direct ownership definition of foreign direct investment leads to foreign affiliates ultimately owned through indirect linkages being included in the domestic firm data set. This is not insignificant: as previously noted, more than 30% of foreign affiliates firms are indirectly owned through a domestic entity (UNCTAD 2016). If foreign affiliates are on average more productive than domestic firms (Girma et al., 2015), this incorrect categorization will upward bias the estimated productivity of domestic firms, and downward bias the estimated productivity of foreign firms. Similarly, including the domestic MNEs in the domestic firm dataset also upward biases the productivity of the set of 'pure' domestic firms. Thus, previous studies have perhaps stacked the cards against finding positive spillover effects from the presence of foreign firms!

3. DATA

Our database is the ORBIS dataset owned by Bureau Van Dijk and used by the 2016 World Investment Report.[3] We focus on the European subset of ORBIS (the Amadeus database) as it offers the longest firm-level panel dataset within ORBIS. We use both the older Amadeus DVDs and the online ORBIS versions to supplement each other. Being careful of how we categorise a firm as domestic or foreign, we acquire DVDs with single releases of the data for the 2003 to 2010 period. We are thereby able to track the changes that have happen in firms' ownership structure. This allows us to create a consistent unbalanced firm-level panel dataset for approximately 2.5 million manufacturing firms between $2001 - 2008$ with full ownership and financial data. Appendix 1 describes the details of how we cleaned and prepared the dataset.

The invaluable advantage of the ORBIS dataset is that it provides the global ultimate ownership (GUO) variable that we need here. Bureau van Dijk has carefully collected this information and built it

[3] We work with the detailed ORBIS version where all firms with 5 or more employees are included. For a detail account of ORBIS see Fons-Rosen et al. () and Kalemli-Ozcan et al. (2015).

in their multi-country dataset. Of course, ownership of an affiliate does not always reflect control. Shareholdings in affiliates provide the rights to not only dividends but also voting rights. Control requires the ability to affect strategic decisions through the exercise of voting rights (WIR 2016) and thus requires one to distinguish between voting and non-voting shares when considering ownership. The ORBIS database tracks control rather than merely ownership. Hence, when share categories are split into voting and non-voting, the ownership percentages recorded are those linked to the category of voting shares. ORBIS categorises an ultimate owner based on having a voting control at 50.01% or higher.[4]

Using both the direct ownership shares and whether a firm has or not an ultimate owner, we define different firm sets as follows:

- $FDI10$: firms where a single foreign owner directly owns at least 10% of shares.
- $FDI50$: firms where a single foreign owner ultimately owns at least 50% of shares.
- I-$FDI50$: firms that are $FDI50$ but not $FDI10$. These firms are foreign owned through indirect ownership links.
- D-$FDI50$: firms that are both $FDI50$ and $FDI10$. These firms are foreign owned through direct ownership links.
- $MNE50$: firms which ultimately own subsidiaries in other countries and are not $FDI50$.
- Pure domestic firms: firms that are neither $FDI10$ nor $FDI50$ nor $MNE50$.

Figure 2 below — the "egg" — illustrates the distribution of our ownership data according to the above definitions. This is based on a total of $2,343,495$ observations (firms-years), which corresponds to roughly $575,000$ firms.[5]

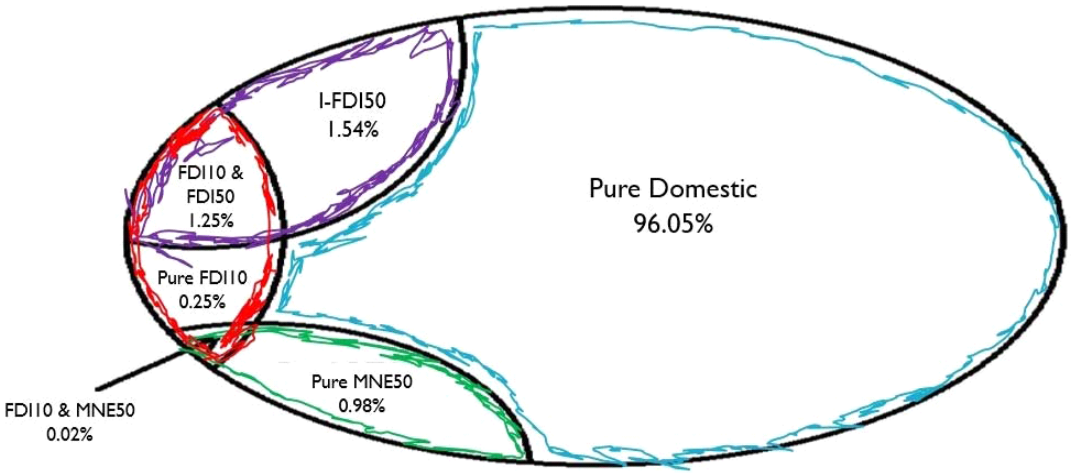
As seen, the large majority of the observations are purely domestic firms ($96,05\%$ or $2,250,817$ obs) – the set outlined in blue. While $FDI50$ observations (the purple set) make up about $3\%(65,475$ obs) of the data, $MNE50$ (the green set) are around $1.0\%(21.257$ obs) and the $FDI10$ observations (the red set) around $1.5\%(35,742$ obs). An observation by definiton cannot be $FDI50$ and $MNE50$ at the same time. When focusing on the standard definition of 'foreign' ($FDI10$) we see an overlap with our $FDI50$ definition, i.e. firms can both have a single foreign shareholder owing at least 10% of the votes and be controlled ultimately by a single foreign firm – the directly controlled firms (D-$FDI50$). The overlap with $MNE50$ is negligible as very few domestic MNEs have a single foreign stakeholder owning more

[4] Due to this, ORBIS is carefull in using a controlling share in each indirect link before it classifies a firm as ultimatedly owned by a foreign entity. Thus, owning a 40% in the first link and 60% in the second link does not qualify for ultimatedly owning the second link by at least 50% — a more than 50% ownership needs to exist in both links.

[5] Note: the percentages in the figure are calculated based on data after cleaning and trimming but before TFP estimations have been performed. We have chosen to illustrate the spilt of the data according to observations and not firms as some firms change ownership status during the sample period. The focus on observations and not on firms avoids 'double-counting'.

than 10% of its equity.

Figure 2: Illustration of ownership data



Note: Own calculations using $2001 - 2008$ firm level data from ORBIS. The figure does not reflect the relative proportions.

The activity data among the different sets of firms reveals an interesting pattern. The descriptive statistics are seen in Table 1 below.[6]

Table 1: Activity data summary statistics

	Obs.	**Firms**	**Sales** (1000 USD)	**Labour**	**Capital** (1000 USD)	**Material** (1000 USD)	**Labour Productivity**
Total	2,343,495	575,844	9,303	49	1,653	5,183	140
FDI10	35,742 (1.5%)	13,007 (2.3%)	82,105	283	13,314	48,970	319
FDI50	65,475 (2.8%)	21,146 (3.7%)	103,350	340	16,757	61,785	366
I-FDI50	36,149 (1.54%)	6,014 (1.04%)	118,865	381	19,134	70,872	398
MNE50	21,257 (0.91%)	7,520 (1.31%)	209,645	567	30,771	118,131	342
Pure domestic	2,250,817 (96.05%)	555,033 (96.43%)	4,544	36	918	2,389	131

Note: own calculations using the $2001 - 2008$ firm level data from ORBIS.

Table 1 shows that the purely domestic firms are on average considerably smaller and less productive than foreign firms. It also shows that the $FDI10$ firms seem to be smaller than other foreign firms. In

[6] For the categorization of the number of firms we have consistently classified a firm to a category based on the last year's information about ownership. This has been done to avoid double counting of firms that change ownership status during the sample period. Labour productivity is defined as sales over number of employees from the firm-level data and not as the ratio of columns 3 and 4.

particular, the $FDI50$ and, especially, the I-$FDI50$ firms are larger and more productive (in terms of labour productivity; TFP will be derived later on). The domestic multinationals ($MNE50$) (that is, the approx. $5,000$ European MNEs' HQ) are by far the biggest firms in terms of activity data but not in terms of (labour) productivity.[7] The most productive firms of all are the indirectly owned foreign firms (I-$FDI50$). These are the firms that the IMF definition will not capture as foreign and thus will be considered as domestic.

Trying to understand whether these indirectly controlled foreign firms are located in any particular country, Table 2 ranks the prevalence of these firms across countries.

Table 2: around here

As seen, there is a higher representation of these firms in the western european countries (1.64%) compared to the eastern european countries (1.19%). The extreme case is Netherlands where 20.29% of all Dutch firms are indirectly owned by foreigners. This, of course, can be related to the special tax regime that Netherlands has for companies with large intangible assets (Dischinger and Riedel, 2011).

Having established that it matters how we define a foreign firm, it is important now to showcase the importance of such measurements issues for policy issues. The 2016 World Investment Report focuses on how these complex ownership issues affect International Investment Agreements and in general policies for attracting FDI. In particular, they showcase the situation where subsidies designed to attract foreign firms end up in the hands of (in reality) domestic firms. Our aim in this paper will be to show that these measurement issues affect the measurement of the FDI-induced productivity spillovers on domestic firms.

4. Empirical strategy

As mentioned above, our contribution to this literature is in considering an alternative definition of what is a 'foreign' firm. We otherwise follow the literature in running FDI productivity spillover regressions using a domestic firm-level measure of TFP and a measure to indicate the degree of 'foreign' presence in a market. However, and different from previous studies, we will run these regressions both with the traditional and our new definition of what is foreign. In doing so, we will pay careful attention that it is this change that explains potential differences in results.

We proceed by explaining how we define the variables that enter our regressions. We start with our main explanatory variable, viz. 'foreign' presence. This is defined as follows:

$$HP_{jct} = \frac{\sum_{i=1,\text{ in } jct}^{N} SALES_{it} * FDI_{it}}{\sum_{i=1,\text{ in } jct}^{N} SALES_{it}}$$

[7] As we will see, the same result holds when calculating total factor productivity for the different firm categories. One should note, however, that for especially MNE HQs there will be an issue of profit shifting, i.e. not reporting the appropriate revenues to the HQ country where taxes are usually higher than taxes in small European countries. In a different but related project we focus on correcting productivity estimations by taking into account the extent of profit shifting a MNE will have.

Horizontal presence (HP) is defined as the share of sales of foreign firms in a given 3-digit industry j within a given country c and for a given year t. In this sense, a market is defined as an industry-country-year combination and for each of these combinations we derive an HP value.[8] The FDI_{it} indicator in the above formula is a binary variable that takes the value of 1 if the firm is foreign and 0 if the firm is domestic.[9] Clearly, how we categorize firms will matter for the nominator of the above formula; the denominator will not be affected as this is the total sales in that particular industry-country-year combination. Our HP measure will be affected by whether we define firms to be foreign using the $FDI10$ definition or the $FDI50$ definition (we can even focus within the $FDI50$ set of firms and look only at the I-$FDI50$ firms). Table 3 below reports the distribution of the HP variable for each of the above definitions.

Table 3: Distribution of HP for each definition of 'foreign'

	Mean	**SD**	**P10**	**P50**	**P90**
HP_{FDI10}	0.0765	0.1078	0	0.0338	0.1950
HP_{FDI50}	0.1560	0.1709	0.0061	0.0911	0.3924
$HP_{I-FDI50}$	0.0924	0.1206	0	0.0449	0.2480

Note: own calculations using the $2001-2008$ firm level data from ORBIS. SD stands for standard deviation. P50 is the median of the distribution, while P10 and P90 are low and high centiles.

As seen, both the mean and the median of the HP variable differs significantly depending upon the definition of 'foreign' used in the calculations. For example, while foreign presence is 7.6% under the $FDI10$ definition of 'foreign', it is 15.6% under the $FDI50$ definition. A focus on the median may be justified as the distributions of the HP measures are quite skewed.

We now move on to explain how we derive our indepedent variable, the domestic firms' total factor productivity (TFP). To derive TFP we estimate a production function (a revenue-based Cobb Douglas production function in our case) using the procedure suggested by Ackerberg et al. (2006, 2015) and modified by De Loecker (2011), De Loecker and Warzynski (2012), and De Loecker et al. (2016). This so-called ACF procedure is an extension of the GMM procedures suggested by Olley and Pakes (1996) and Levinshon and Petrin (2003). While all three procedures are designed to handle the potential endogeneigty of the input variables, the ACF procedure is able to address collinearity problems present in the OP and LP procedures.[10] De Loecker (2011) is the first that modifies the ACF procedure by allowing more

[8] The use of sales is sometimes in the literature substituted by employment levels. We have used both measures and found a correlation of 0.94 between an HP-sales and an HP-employment index. We have also rerun all our regressions using an employment-based HP variable and we get the same qualitiative results. In what follows we use the HP-sales index.

[9] Javorcik and Spatareanu (2008) are one of the few studies that look at the degree of foreignness and not just whether you are or not a foreign firm. They use the foreign share of direct ownership as a continuous variable and they show that firms with higher foreign direct ownership exert a higher spillover effect to domestiv firms. Our analysis, by focusing on ultimate ownership, cannot do that as the ultimate ownership variable is not a continuous variable.

[10] For yet a different method see Wooldridge (2009).

variables (than just lagged productivity) to appear in the productivity law-of-motion function. In the present paper we use this 'modified ACF procedure' for our estimation of total factor productivity.

The main equation of the procedure is the production function equation, logarithmically transformed:

$$lnY_{it} = \beta_0 + \beta_1 lnL_{it} + \beta_2 lnK_{it} + \beta_3 lnM_{it} + \omega_{it} + \epsilon_{it} \quad (1)$$

where Y is sales or revenues, L is labour input (number of employees), K is capital input (in value terms), M is material input (in value terms),[11] ω is the unobserved (to the econometrician but not the firm manager) productivity and ϵ is the error term (unobserved to both the firm manager and the econometrician).

The modified ACF procedure involves a stepwise implementation. First of all it assumes that labor and capital inputs are decided before materials and that productivity evolves according to a Markov process. The first step is then used to isolate productivity ω from the unobserved error term ϵ. All input coefficients are estimated in the second step under the assumption that productivity follows a law-of-motion function that determines how productivity evolves as a function of lagged productivity and other lagged explanatory factors (see De Loecker 2011). We adopt a version of the law-of-motion that adds the lagged HP measure to the regressors, i.e. $\omega_{it} = g_t(\omega_{it-1}, HP_{jt-1})$. The intuition for doing that is that we believe managers know how much foreign horizontal presence there is and thus they take this into account when employing labour and capital. This law-of-motion allows us later on to derive changes in productivity that are not predicted by the firm's management. These changes will be uncorrelated with input variables from the previous period and also with material from the same period (due to the assumption about the order in which the decisions are made). Therefore the productivity innovations and the instruments (lagged input variables and contemporaneous material) form the moment conditions on which the GMM estimation rests. The final coefficient estimates of lnL, lnK and lnM from (1) are then derived by GMM (see Appendix 2 where the STATA code is provided – only for referees).

4.1. Regressions. Having explained how we derive our TFP measure and the horizontal presence measure of foreign activity, we now present the basic regression model:

$$TFP_{ijct} = \alpha_i + \beta_1 HP_{jct} + \beta_2 HP_{jct-1} + \beta_3 D_t + \beta_4 D_t x D_j + \beta_5 D_t x D_c + \varepsilon_{ijct} \quad (2)$$

where i refers to a domestic firm, j refers to a 2-digit industry, c refers to a country, and t refers to a year. In order to remove any influence from time invariant firm specific variables we estimate equation (2) using firm-fixed effects.[12]

[11] See Appendix 1 that describes how we prepare our data step by step.

[12] We have also experimented with including Herfindahl indices of competition as controls in our horizontal penetration regressions. As it turns out these indices never became significant, so we dropped them again (see the robustness section). Moreover, instead of using a fixed effect estimator we re-run our regressions using first differences. As it can be seen in our robustenss section, the main results of our analysis do carry over.

We use both the contemporaneous and the lagged values of the HP variable as our explanatory factors of main interest. We do this recognizing that spillover effects may take time. The current specification of equation (1) that includes the lagged HP measure, allows for consistency with the Markov(1) assumption of the ACF-method for estimating TFP. Notice that by including both HP and lagged-HP, the long-run effect of a change in HP will be the sum of the two first beta coefficients $(\beta_1 + \beta_2)$. As HP and lagged-HP are often highly correlated (often around 0.90), it may be difficult to obtain statistical significance for the individual coefficients while their combined significance can be tested by means of an $F-$test. In models with both HP and lagged HP we will report the result of such an $F-$test as well.

In the specification of (2) we allow for time fixed effects by using the D_t dummy. With 7 years of data it makes sense to allow for different means in TFP for each year in addition to the HP effects. We also include the interaction dummies for year and industry, and year and country, to allow the effects of industry and country to vary over the years. Including the full set of fixed effects constitutes our most robust regressions.

In the next section we present different estimations of (2) depeding of how we define 'foreign'. As we will see, the coefficients vary significantly. However, as pointed out earlier, the definition of 'foreign' affects both the sample of domestic and foreign firms and the actual estimation of TFP (as HP enters the productivity law-of-motion function). In separating the different effects, we start out by adopting the IMF definition of what is foreign ($FDI10$) and derive some results. We then do the same by adopting our preferred definition of 'foreign'($FDI50$) and we compare the estimates.

However, in doing the above, the set of domestic firms will be affected and thus it cane that the different results are due to a different set of domestic firms (and not due to a different set of foreign firms). In a second set of regressions we perform the same comparison but on the set of domestic firms that always stay domestic, i.e. the *pure domestic* firms (see Figure 2) — these are the firms that one should be interested as the rest can have productivity effects due to their exposure to some degree of multinationality. This set of pure domestic firms excludes the domestic multinationals ($MNE50$) and is constant across the definitions of what is a 'foreign' firm.

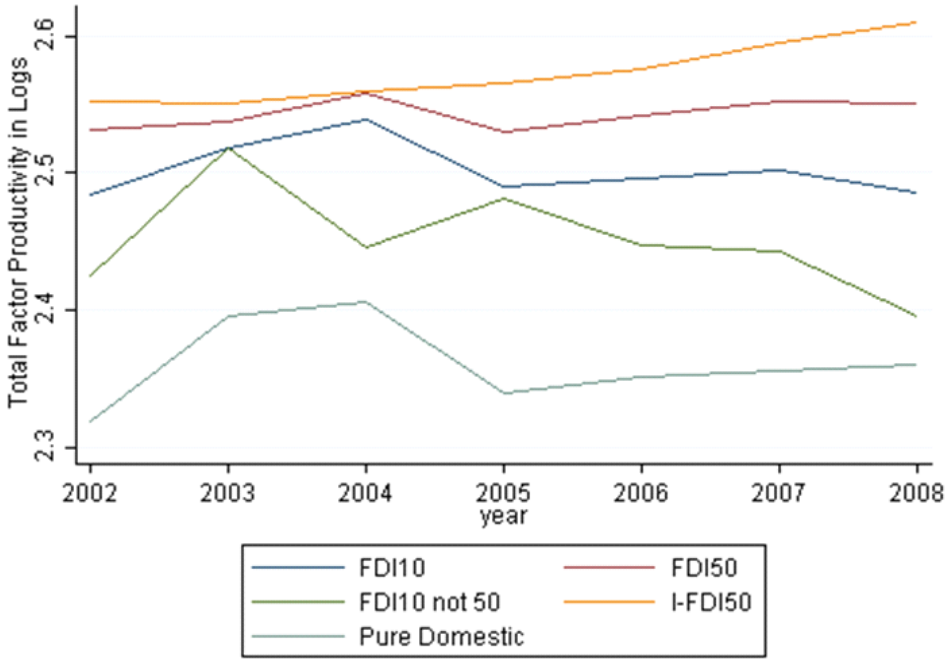
In a third set of regressions we make sure that our results are not due to the different TFP estimates derived due to the use of different foreign presence measures. As mentioned above, managers have knowledge of the market conditions prior to deciding how much labour and capital to employ. Since the extent of foreign presence is something that affects market conditions, we introduced the HP variable in the productivity law-of-motion. Thus, depending which HP variable we use, a different TFP estimate will be derived. To control for that variation, our third set of regressions assume that managers' knowledge about foreign penetration is best captured by all foreign firms, i.e. the *union* of $FDI10$ and $FDI50$ sets. By setting $HP_{FDI10} + HP_{FDI50}$ in the productivity of law of motion we thus estimate a single domestic firm TFP that we then use in regression (2) above. We consider this set of regressions to be the most credible for the effect we try to estimate.

In our fourth and final set of regressions we expand by splitting the $FDI50$ set foreign firms to two subsets, viz. I-$FDI50$ and D-$FDI50$. By including each of them in the spillover regression we can isolate the importance of having in this paper identified the I-$FDI50$ firms; 4to emphasize, these are the firms that previously were categorised as domestic.

5. RESULTS

We start by presenting the evolution of the TFP estimates for different firm sets. In using the above described 'modified ACF' method we use "all foreign firms", i.e. the union of $FDI10$ and $FDI50$, in the productivity law-of-motion function.

Figure 3: The evolution of TFP across time for different firm classifications



As seen the most productive of all firms is the I-$FDI50$ set of firms. These are the firms that consistently lie above all other firms and through time have increased their productivity. The $FDI10$ set (the blue line) is substantially less productive. If from that set we remove the firms that also belong in the $FDI50$ set, then we get the '$FDI10$ not 50' set (the green line) that, through the years, exibit a reduction of their productivity and are now close to the productivity of the pure domestic firms (the bottom grey line). Thus, while I-$FDI50$ firms become more productive through time, the $FDI10$ firms become less productive.[13] Finally, the fact that '$FDI10$ not 50' firms are less productive than $FDI10$ firms is consistent with the

[13] We checked whether this tendency is in anyway connected to how I-$FDI50$ observations are distributed through the years and we saw no pattern emerging — there is a more or less an equal number of I-$FDI50$ obeservations in each of the years.

control story that we are proposing, viz. firms controlled by an ultimate owner experience a greater transfer of knowledge and thus are more productive than firms that are not ultimately controlled. Of course such considerations say nothing about which set of firms have a greater spillover effect to domestic firms, which is the central theme of our analysis and to which we trurn now.

Our first set of regressions are presented below in Table 4. As mentioned above, we run spillover regressions with two different definitions of what is 'foreign'; the $FDI10$ and the $FDI50$. In doing so we start by defining a firm as domestic if it is not foreign (as many in the literature have done). Due to this, the number of observations changes between the $FDI10$ and the $FDI50$ regressions (it is higher in the $FDI10$ regressions as that definition categorizes fewer firms as foreign). The first five columns use the $FDI10$ definition, while the last five columns use the $FDI50$ definition. Each column is a different combination of the fixed effects that we include as controls.

Table 4: around here

While with no or few fixed effects the $FDI10$ regressions show positive and significant spillovers (see the coefficients of the HP_t and HP_{t-1} variables), controlling for all posible fixed effects (see collumn #5) makes the significance of these results to disappear. The joint $F-$test reveals that the sum of the conterporaneous and lagged HP effect is not statistically different from zero.[14] Thus consistent with the literature, when a careful consideration of all possible fixed effects can be used, there seems to be no spillover effect whatsoever. This, however, is not the case in the $FDI50$ regressions, where the positive spillover coefficients sustain their power even when all fixed effects are included (collumn #10).

However, as mentioned above, table 4 regressions are done on a different set of domestic firms and thus it could be that the different results are due to this. Running the same regressions on the same set of domestic firms — the so-called, *pure* domestic firms, i.e. the domestic firms that are not $FDI10, FDI50$, nor $MNE50$ — does not change the above results. Table 5 below reports these results.

Table 5: around here

As in table 4, the $FDI10$ regression with all fixed effects included (collumn #5) shows no statistical significance for the long-run spillover effect to pure domestic firms. In contrast, the $FDI50$ regression (collumn #10) does provide evidence that pure domestic firms are positively affected by the presence of foreign firms within the same industry, country, and year.

However, while the set of domestic firms is now the same, the TFP estimate of these domestic firms differs according to whether we use the HP_{FDI10} or the HP_{FDI50} in the productivity law-of-motion. To remove that variation, we now run the same regressions assuming that it is the *union* of $FDI10$ and

[14] We also run the regressions in steps having only the contemporaneous and only the lagged HP variables without any difference. For brevity, we report here only the regressions where both variables are included at the same time.

$FDI50$ that matters in managers' production input decisions.[15] As we see in table 6, nothing substantial changes; while the spillovers from the presence of $FDI10$ foreign firms are still not there, the presence of $FDI50$ firms exerts a positive and statistical significant productivity effect on pure domestic firms.

Table 6: around here

In trying to highlight the importance of the I-$FDI50$ firms, i.e. firms that are classified as 'foreign' due to indirect ownership links but previously categorised as domestic, we split the $FDI50$ set of firms in two subsets and run the same regressions as in table 6 above. Table 7 below reports the results.

Table 7: around here

As we split the $FDI50$ set to its two components, i.e. the directly controlled $FDI50$ (D-$FDI50$) and the indirectly controlled $FDI50$ (I$-FDI50$), we see that it is the latter component that has the biggest and most significant spillover effect on pure domestic firms. Thus, we do find evidence that these indirectly controlled foreign firms exert a positive externality in that they raise the productivity of domestic firms in the same industry. By not identifying them as foreign firms, and by actually categorising them as domestic firms, studies that use direct ownership data inevitably fail to capture this.

We end this section by looking at the economic significance of our results. We focus on the coefficients reported in Table 6, which we see as our best analysis.

Note that a 1 percentage point increase in HP (i.e. increasing by 0.01) implies a long run increase in TFP by 0.052% ($= 0.037 + 0.015$; see column 10, table 6). However, as the standard deviation in HP is much larger than 0.01 it would make more sense to look at the effect of a one standard deviation change in HP. From Table 3 we see that the standard deviation of HP for $FDI50$ is 0.17. The effect of a change in HP of 0.17 will then equal $0.17 \times 0.053 \times 100 = 0.90\%$ in TFP. A close to 1% effect is in fact economically significant as it implies that (to be calculated)... Of course, the above numbers are overall averages and if we looked at particular countries and industries the effects may differ substantially. For example, the change in HP for Sweden from 2004 to 2005 in the "Manufacture of electricity distribution and control apparatus" (3 digit industry classification #31.2) was 0.77 which leads to an effect on TFP of $0.77 \times 0.052 \times 100 = 4.08\%$. The change in HP for Norway from 2005 to 2006 in "Manufacture of articles of concrete, plaster and cement" (3 digit industry classification #26.6) was 0.25 which leads to an effect on TFP of $0.25 \times 0.052 \times 100 = 1.33\%$. Finally, for Italy from 2006 to 2007 in "Manufacture of vegetable and animal oils and fat" (3 digit industry classification #15.4) the change in HP was 0.15 and the effect on TFP was $0.15 \times 0.052 \times 100 = 0.80\%$.

[15] This is intuitively the most likely case. Managers do know which firms are foreign within their industry and take this into consideration when employing inputs.

6. ROBUSTNESS CHECKS

In what follows we perform a number of extentions to get further insights on the robustness and nature of our results.

We start by running the same regressions as those presented in table 6 and control for the effect that the industry's concentration may have on productivity. We capture this we calculate the Hrfidahl index by using the ORBIS data.[16] We find that our results do not change and that the Herfindahl index explains none of the variation in TFP (not reported here for brevity).

The next analysis departs from OLS regressions around the mean of TFP and uses quantile regressions techniques that pay careful attention to the heterogeneigty of the TFP variable. Such a method will reveal whether the spillover effects are sensitive to the intial level of domestic TFP, i.e. an absorptive capacity type of argument.

To provide some intuition on the use of the quantile regressions note that so far we have been working with standard regressions, where we model the conditional mean of TFP as a function of HP measures and some controls. This means that we have been modelling a central measure of the TFP distribution. In a case like ours where we expect a lot of heterogeneity to be present, it may also be of interest to consider how other parts of the distribution is affected. An econometric tool suited for such a study is a quantile regression as originally introduced in by Koenker and Basset (1978). By directly modelling conditional quantiles of the distribution of TFP by a linear expression in the explanatory variables, we will allow the tails of the TFP distribution (e.g. the quartiles) to be affected differently from the central part of the distribution (e.g. the median). The technique has been extended during the past twenty years to also apply to panel data, but unfortunately applications to panel data models with fixed effects have not found a satisfactory solution yet — see studies by e.g. Koenker (2004), Canay (2011), Powell (2015). In general there are problems with identification of the additive fixed effects, and also estimation itself is computationally cumbersome. For this reason we restrict our discussion of the use of quantile regression methods to a robustness section. An easy and intuitive way to circumvent the problems with panel fixed effects models could have been to simply divide our sample into quartiles based on a ranking of the TFP measures and then estimate models like the ones we used in our previous sections on each of these sub samples. However, as stated in Koenker & Hallock (2001) such a procedure will suffer from a selection bias. Instead, here we present results based on the two step procedure suggested by Canay (2011).

The two steps of the procedure are as follows:

1. We estimate the fixed effects by using the same estimation that produced the results of table 6. Even though not reported in that table, we obtain estimates of the firm individual fixed effects and these are subtracted from the TFP measures to produce 'fixed effects corrected' TFP measures for each firm-year.

[16] We note however that revenue data from accounting sources do not distingish between domestic sales and exports.

2. In the second step a traditional quantile regression procedure is used for the 25%, 50% and 75% quartile of the 'fixed effects corrected' TFP from step 1 with the same set of observable regressors.

The results of the Canay-procedure are displayed in table 8 both for the whole sample and for West and East european countries separately. For brevity, we only report regressions where all fixed effects are included and we only focus on the $FDI50$ sample, where positive overall horizontal spillovers were found.[17]

Table 8: around here

First of all notice that the overall picture for productivity spillovers does not seem to show much quantile dependence. The effects for most of the selected quantiles are very close to what we found in table 6 with a slight tendency to drop at the higher end of the distribution. For the East/West split we find indications that the effects are stronger in the East and stronger in the low end of the distribution — there is no productivity spillover effect on the high end of the West domestic distribution. Overall it seems that we have not missed important features of our analysis by initially employing a panel data model of the conditional mean.

7. CONCLUSIONS

This paper questions the very basic definition of what is a foreign firm, and generates novel findings. We theorised that control over decision making by a foreign firm, rather than influence, is a more important basis by which spillover effects are exerted. Further, by accepting the complex, empirical reality of the world we live in, we recognised that indirect ownership structures are more prevalent than direct ownership structures. We then argued that any study using direct ownership data to identify "foreign" firms is bound to underestimate foreign presence, and thereby bias the results against finding positive horizontal spillovers.

Our findings support our conjecture. While we confirm the general thread of previous research that the presence of $FDI10$ foreign firms has a (statistically) zero spillover effect on domestic firms, we find that the presence of $FDI50$ foreign firms, i.e. firms that are foreign ultimately owned and thus controlled, has a positive and significant spillover effect. This result holds for the same set of domestic firms and thus it is this alternative measurement of what is 'foreign' that explains the positive horizontal spillover result, and not the alternative measurement of what is 'domestic'. We also offer some evidence to indicate that it is especially the indirectly controlled foreign firms that exert the most persistent horizontal spillover effects to domestic firms. Importantly, it is is that set of firms that studies using the IMF definition

[17] Despite its intuitiveness and simplicity to use, we do realize that this method is not perfect either.When calculating the standard errors of the second step, this method does not take into account the uncertainty in relation to the estimation of the fixed effects in the first step. We expect the additional uncertainty to inflate the standard errors somewhat. To correct on this we bootstrapped the standard errors to take into account the error correlation between the different quartiles. As our bootsrapping did not perfectly converged, we report here the current t-statistics which undoutedly are quite high.

would have missed and categorized as domestic firms.

Interest in FDI induced productivity spillovers has generated literally hundreds of published papers, and continues unabated. Instead of seeking out new country dataset, or using new econometric methods, or finding new instruments that will allow us to claim causality, we have challenged a commonly used assumption in all prior literature. We believe there is a need for quasi-replication studies akin to those advocated by Bettis et al. (2016). That is, the alternative definitions we propose could be applied to a re-analysis of existing panel dataset in which the ultimate owner can be identified, as well as inform research designs in entirely new studies. Indeed, establishing the importance of ultimate ownership and, in particular, of indirect ownership chains is a fact that can be applied across many literatures and research questions.

References

[1] Ackerberg, D.A., K. Caves, and G. Frazer (2006). Structural identiffication of production functions, mimeo.

[2] Ackerberg, D.A., K. Caves, and G. Frazer (2015). Identification properties of recent production function estimators, *Econometrica* 83, 2411–245

[3] Aitken, B. J. and A.E. Harrison (1999). Do domestic firms benefit from direct foreign investment? Evidence from Venezuela. *The American Economic Review* 89, 605-618.

[4] Allred, B.B., M.G. Findley, D. Nielson, and J.C. Sharman (2017). Anonymous shell companies: A global audit study and field experiment in 176 countries. *Journal of International Business Studies* 48, 596-619.

[5] Altomonte, C., and E. Pennings (2009). Domestic plant productivity and incremental spillovers from foreign direct investment. *Journal of International Business Studies* 40, 1131-1148.

[6] Bartlett, C., and S. Ghoshal. (1989). *Managing across borders: The transnational solution.* 1st ed. Boston: Harvard Business School Press.

[7] Békés, G., J. Kleinert and F. Toubal. (2009). Spillovers from multinationals to heterogeneous domestic firms: evidence from Hungary. *The World Economy* 32, 1408-1433.

[8] Beugelsdijk, S., T. Pedersen, and B. Petersen (2009). Is there a trend towards global value chain specialization? An examination of cross border sales of US affiliates. *Journal of International Management* 15, 126-141.

[9] Betis, R.A., C.E. Helfat, and J.M. Shaver (2016). The necessity, logic, and forms of replication. *Strategic Management Journal* 37, 2193-2203.

[10] Blalock, G. and P.J. Gertler. (2009). How firm capabilities affect who benefits from foreign technology. *Journal of Development Economics* 90, 192–199.

[11] Blalock, G. and P.J. Gertler (2008). Welfare gains from foreign direct investment through technology transfer to local suppliers. *Journal of International Economics* 74, 402–421.

[12] Blalock, G. and P.J. Gertler (2009). How firm capabilities affect who benefits from foreign technology. *Journal of Development Economics* 90, 192-199.

[13] Blomström, M. and H. Persson (1983). Foreign investment and spillover efficiency in an underdeveloped economy: evidence from the Mexican manufacturing industry. *World Development* 11, 493–501.

[14] Canay, I.A. (2011). A simple approach to quantile regression for panel data. *Econometrics Journal* 14, 368-386.

[15] Castellani, D. & Zanfei, A. (2003). Technology gaps, absorptive capacity and the impact of inward investments on productivity of European firms. *Economics of Innovation and New Technology* 12, 555-576.

[16] Caves, R.E. (1974). Multinational firms, competition and productivity in host-country markets. *Economica* 41, 176-193.

[17] Chang, J.J. and D. Xu (2008). Spillovers and competition among foreign and local firms in China. *Strategic Management Journal* 29, 495-518.

[18] De Loecker, J. (2011). Product differentiation, multiproduct firms, and estimating the impact of trade liberalization on productivity, *Econometrica* 79, 1407–1451.

[19] De Loecker, T. (2013). Detecting learning by exporting, *American Economic Journal: Microeconomics* 5, 1–21.

[20] De Loecker, J. (2011). Recovering markups from production data, *International Journal of Industrial Organization* 29, 350-355.

[21] De Loecker, J., P.K. Goldberg, A.K. Khandelwal, and N. Pavcnik (2016). Prices, markups, and trade reform, *Econometrica* 84, 445–510.

[22] De Loecker, J. and F. Warzynski (2012). Markups and firm-level export status, *American Economic Review* 102, 2437-2471.

[23] Dischinger, M. and N. Riedel (2011), Corporate taxes and the location of intangible assets within multinational firms. *Journal of Public Economics* 95, 691–707.

[24] Dharmapala, D. and N. Riedel (2013). Earnings shocks and tax-motivated income-shifting: Evidence from European multinationals, *Journal of Public Economics* 97, 95–107.

[25] Eden, L. (2009). Letter from the Editor-in-Chief: FDI spillovers and linkages. *Journal of International Business Studies* 40, 1065-1069.

[26] Fu, X. (2012). Foreign direct investment and managerial knowledge spillovers through the diffusion of management practices. J*ournal of Management Studies* 49, 970-999.

[27] Görg, H. and D. Greenaway (2004). Much ado about nothing? Do domestic firms really benefit foreign direct investment? *The World Bank Research Observer* 19, 171-197.

[28] Görg, H. and E. Strobl (2001). Multinational companies and productvity spillovers: a meta-analysis. *The Economic Journal* 111, 723-739.

[29] Görg, H. and E. Strobl (2005). Spillovers from foreign firms through worker mobility: an empirical investigation. *Scandinavian Journal of Economics* 107, 693-709.

[30] Haddad, M. and A.E. Harrison (1993). Are there positive spillovers from direct foreign investment? Evidence from panel data for Morocco. *Journal of Development Economics* 42, 51-74.

[31] Hart, O. (1995). *Firms, Contracts and Financial Structure*. Clarendon Lectures in Economics. Clarendon Press.

[32] Hart, O. (2017). Incomplete contracts and control. *American Economic Review* 107, 1731-1752.

[33] Hart, O. and L Moore, J. (1990). Property rights and the nature of the firm, *Journal of Political Economy* 98, 1119-1158.

[34] Haskel, J.E., S.C. Pereira, and M.J. Slaughter (2007). Does inward foreign direct investment boost the productivity of domestic firms? *Review of Economics and Statistics* 89, 482-496.

[35] Havranek, T. and Z. Irsova (2011). Estimating vertical spillovers from FDI: Why results vary and what the true effect is? *Journal of International Economics* 85, 234-244.

[36] Helpman, E., M.J. Melitz and S.R. Yeaple (2004), Export versus FDI with heterogeneous firms, *American Economic Review* 94, 300-316.

[37] Huizinga, H. and L. Laeven (2008). International profit shifting within multinationals: A multi-country perspective, *Journal of Public Economics* 92, 1164-1182.

[38] Hymer SH. (1960). *The International Operations of National Firms: A Study of Direct Foreign Investment*. MIT Press: Cambrige, MA

[39] Javorcik, B.S. (2004). Does foreign direct investment increase the productivity of domestic firms? in search of spillovers through backward linkages, *American Economic Review* 94, 605–627.

[40] Javorcik, B.S. (2008). Can survey evidence shed light on spillovers from foreign direct investment?, *World Bank Research Observer* 23, 139–159.

[41] Javorcik, B.S. and M. Spatareanu (2011). Does it matter where you come from? vertical spillovers from foreign direct investment and the origin of investors, *Journal of Development Economics* 96, 126–138.

[42] International Monetary Fund (1948). Balance of Payments Manual, first edition (BPM1), Washington D.C., USA.

[43] International Monetary Fund (1950). Balance of Payments Manual, second edition (BPM2), Washington D.C., USA.

[44] International Monetary Fund (1961). Balance of Payments Manual, third edition (BPM3), Washington D.C., USA.

[45] International Monetary Fund (1977). Balance of Payments Manual, fourth edition (BPM4), Washington, D.C., USA.

[46] International Monetary Fund (1993). Balance of Payments Manual, fifth edition (BPM5), Washington, D.C., USA.

[47] International Monetary Fund (2009). Balance of Payments Manual, sixth edition (BPM6), Washington, D.C., USA.

[48] Kalemli-Ozcan, S., B. Sorensen, C. Villegas-Sanchez, V. Volosovych, and S. Yesiltas (2015). How to construct nationally representative firm level data from the ORBIS global database: NBER WP:21558.

[49] Koenker, R. (2004). Quantile regression for longitudinal data. *Journal of Multivariate Analysis* 91, 74-89.

[50] Koencker, R. and G. Bassett (1978). Quantile Regression. *Econometrica* 46, 33-50.

[51] Koenker, R. and K.F. Hallock (2001). Quantile Regression. *Journal of Economics Perspectives* 15, 143-156.

[52] Keller, W. and A.R. Yeaple (2009). Multinational enterprises, international trade, and productivity growth: firm-level evidence from the United States, *Review of Economics and Statistics* 91, 821–831.

[53] Kosová, R. (2010). Do foreign firms crowd out domestic firms? Evidence from the Czech Republic. The Review of Economics and Statistics, 92(4): 861-881.

[54] Levinsohn, J. and A. Petrin (2003). Estimating production functions using inputs to control for unobservables. *Review of Economic Studies* 70, 317–341.

[55] Liu, Z. (2008). Foreign direct investment and technology spillovers: theory and evidence, *Journal of Development Economics* 85, 176–193.

[56] Lu, Y., Z. Tao, and L. Zhud (2017). Identifying FDI spillovers, *Journal of International Economics* 107, 75-90.

[57] Meyer, K.E., Sinani, E., 2009. When and where does foreign direct investment generate positive spillovers? A meta-analysis. *Journal of International Business Studies* 40, 1075–1094.

[58] Mudambi, R. and M. Venzin (2010). The strategic nexus of offshoring and outsourcing decisions, *Journal of Management Studies* 47, 1510-1533.

[59] Nachum, L. (2010). When is foreignness an asset or a liability? Explaining the performance differential between foreign and local firms. *Journal of Management* 36, 714-739.

[60] Newman, C., Rand, T., Talbort, T. and Tarp, F. (2015). Technology transfers, foreign investment and productivity spillovers. *European Economic Review* 76, 168-187.

[61] Olley, G. S. and A. Pakes (1996). The dynamics of productivity in the telecommunications equipment industry. *Econometrica* 64, 1263–1297.

[62] Powell, D. (2015). Quantile regression with non-additive fixed effects. Working Paper RAND Corporation. Available at http://works.bepress.com/david_powell/1/ (accessed November 2017).

[63] Rugman, A.M. and Verbeke, A. (2001). Subsidiary-specific advantages in multinational enterprises. *Strategic Management Journal* 22, 237-250.

[64] Sjöholm, F. 1999. Technology gap, competition and spillovers from direct foreign investment: Evidence from establishment data, *The Journal of Development Studies* 36, 53-73.

[65] Smeets, R. 2008. Collecting pieces of the FDI knowledge spillovers puzzle, *The World Bank Research Observer* 23, 107-138.

[66] Spencer, J. W. (2008). The impact of multinational enterprise strategy on indigenous enterprises: horizontal spillovers and crowding out in developing countries. *Academy of Management Review* 33, 341–361.

[67] Temouri, Y., N. Driffield, and A. Higón (2008). Analysis of productivity differences among foreign and domestic firms: evidence from Germany, *Review of World Economics* 144, 32-54.

[68] United Nations Conference on Trade and Development (2012). *World Investment Report 2012, Towards a New Generation of Investment Policies,* Geneva.

[69] United Nations Conference on Trade and Development (2016). *World Investment Report 2016, Investor Nationality: Policy Challenges,* Geneva.

[70] United Nations Conference on Trade and Development (2017). *World Investment Report 2017, Investment and the Digital Economy*, Geneva.

[71] Verbeke, A. and W. Yuan (2010). Strategic management analysis of ownership advantages in the eclectic paradigm. *Multinational Business Review* 18, 89-108.

[72] Zaheer S. (1995). Overcoming the liability of foreignness. *Academy of Management Journal* 38, 341–363.

[73] Zhang, Y.A., Y. Li and H. Li. (2014). FDI spillovers over time in an emerging market: the roles of entry tenure and barriers to imitation. *Academy of Management Journal* 57, 698–722.

[74] Zhang, Y., H. Li, Y. Li and L. Zhou (2010). FDI spillovers in an emerging market: The role of foreign firms' country origin diversity and domestic firms' absorptive capacity. *Strategic Management Journal* 31, 969–989.

[75] Zhou, N. and M.F. Guillen (2016). Categorising the liability of foreignness: ownership, location, and internalisation-specific dimensions. *Global Strategy Journal* 6, 309-329.

Table 2: Distribution of foreign firms across countries

Country Code	FDI10	FDI50	I-FDI50	Total Obs.	$\frac{I-FDI50}{Total\ obs}$
NL*	168	377	249	1,227	0.2029
AT*	372	641	325	2,230	0.1457
BE*	2,841	5,299	2,873	20,191	0.1422
DE*	2,659	5,975	3,754	31,852	0.1178
SK	301	896	611	9,831	0.0621
PL	2,672	3,692	1,401	29,893	0.0468
CZ	1,845	3,072	1,549	34,233	0.0452
SI	95	395	311	14,674	0.0211
NO*	759	1,423	763	37,632	0.0202
FR*	8,860	17,222	9,894	501,448	0.0197
HU	462	654	329	19,454	0.0169
FI*	751	1,396	741	51,300	0.0144
BG	247	543	347	28,312	0.0122
SE*	934	2,075	1,377	119,380	0.0115
IT*	4,687	8,760	4,937	445,858	0.0110
ES*	4,477	8,029	4,348	505,929	0.0085
RO	2,807	3,435	1,382	238,312	0.0057
BA	27	71	47	9,786	0.0048
PT*	661	849	321	76,435	0.0042
UA	117	671	590	165,518	0.0035
Total	35,742	65,475	36,149	2,343,495	0.0154
West*	27,196	52,046	29,582	1,793,482	0.0164
East	8,573	13,429	6,567	550,013	0.0119

Note: own calculations using the 2001-2008 firm level data from ORBIS. A star denotes a Western european country.

Table 4: Spillovers to different sets of domestic firms

	$FDI10$					$FDI50$				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
HP_t	0.190^{***} (9.00)	0.143^{***} (7.00)	0.034^{**} (2.84)	0.142^{***} (6.76)	0.030^{*} (2.39)	0.102^{***} (5.30)	0.145^{***} (7.10)	0.033^{**} (3.21)	0.151^{***} (7.01)	0.045^{***} (4.50)
HP_{t-1}	0.232^{***} (11.47)	0.103^{***} (5.36)	0.019 (1.69)	0.086^{***} (4.27)	-0.007 (-0.70)	0.101^{***} (5.09)	0.108^{***} (5.89)	0.001 (0.15)	0.112^{***} (5.71)	0.009 (0.91)
Year	no	yes	yes	yes	yes	no	yes	yes	yes	yes
Year × industry	no	no	no	yes	yes	no	no	no	yes	yes
Year × country	no	no	yes	no	yes	no	no	yes	no	yes
Obs.	1,584,088	1,584,088	1,584,088	1,584,088	1,584,088	1,535,717	1,535,717	1,535,717	1,535,717	1,535,717
R-squared	1.7%	4.9%	22.4%	6.8%	23.7%	0.3%	5.3%	26.2%	7.4%	27.7%
Joint F-Test	183.0	72.67	10.82	58.77	1.780	48.51	75.75	4.679	67.32	12.97
p-value	0.000^{***}	0.000^{***}	0.001^{***}	0.000^{***}	0.182	0.000^{***}	0.000^{***}	0.031^{*}	0.000^{***}	0.000^{***}

Note: t statistics in parentheses. The Joint F-test is a test for no long-run effect i.e. of the hypothesis that both coefficients of HP and HP_lagged are zero at the same time. One star means significance at 5% level, two stars at 1% level and three stars at 0.1% level.

Table 5: Spillovers to pure domestic firms

	$FDI10$					$FDI50$				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
HP_t	0.201^{***} (8.90)	0.159^{***} (7.28)	0.038^{**} (2.91)	0.156^{***} (6.93)	0.031^{*} (2.27)	0.103^{***} (5.21)	0.148^{***} (7.02)	0.0327^{**} (3.09)	0.156^{***} (7.00)	0.044^{***} (4.50)
HP_{t-1}	0.249^{***} (11.29)	0.120^{***} (5.75)	0.017 (1.43)	0.102^{***} (4.66)	-0.012 (-1.04)	0.104^{***} (5.05)	0.111^{***} (5.86)	0.0005 (0.05)	0.117^{***} (5.72)	0.009 (0.84)
Year	no	yes	yes	yes	yes	no	yes	yes	yes	yes
Year × industry	no	no	no	yes	yes	no	no	no	yes	yes
Year × country	no	no	yes	no	yes	no	no	yes	no	yes
Obs.	1,508,277	1,508,277	1,508,277	1,508,277	1,508,277	1,508,277	1,508,277	1,508,277	1,508,277	1,508,277
R-squared	1.9%	5.1%	22.2%	6.7%	23.5%	0.3%	5.4%	26.4%	7.5%	27.9%
Joint F-Test p-value	180.3 0.000^{***}	81.46 0.000^{***}	10.04 0.002^{**}	65.30 0.000^{***}	1.037 0.309	47.09 0.000^{***}	74.10 0.000^{***}	3.97 0.040^{*}	67.08 0.000^{***}	12.54 0.000^{***}

Note: t statistics in parentheses. The Joint F-test is a test for no long-run effect i.e. of the hypothesis that both coefficients of HP and HP_lagged are zero at the same time. One star means significance at 5% level, two stars at 1% level and three stars at 0.1% level.

Table 6: Spillovers to pure domestic firms when the productivity law-of-motion is the same

	$FDI10$					$FDI50$				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
HP_t	0.202^{***} (9.35)	0.159^{***} (7.73)	0.046^{***} (4.00)	0.156^{***} (7.28)	0.039^{***} (3.33)	0.089^{***} (5.05)	0.128^{***} (7.40)	0.028^{**} (3.09)	0.132^{***} (7.33)	0.037^{***} (4.24)
HP_{t-1}	0.231^{***} (11.07)	0.102^{***} (5.19)	0.005 (0.47)	0.083^{***} (4.05)	-0.023^{*} (-2.14)	0.101^{***} (5.37)	0.107^{***} (6.43)	0.012 (1.28)	0.106^{***} (6.42)	0.015 (1.78)
Year	no	yes	yes	yes	yes	no	yes	yes	yes	yes
Year × industry	no	no	no	yes	yes	no	no	no	yes	yes
Year × country	no	no	yes	no	yes	no	no	yes	no	yes
Obs.	1,508,277	1,508,277	1,508,277	1,508,277	1,508,277	1,508,277	1,508,277	1,508,277	1,508,277	1,508,277
R-squared	1.8%	5.0%	22.6%	6.9%	24.0%	0.3%	4.9%	22.6%	6.9%	24.0%
Joint F-Test p-value	190.3 0.000^{***}	81.42 0.000^{***}	10.28 0.002^{**}	63.25 0.000^{***}	0.937 0.333	48.48 0.000^{***}	86.39 0.000^{***}	8.83 0.003^{**}	81.01 0.000^{***}	17.13 0.000^{***}

Note: t statistics in parentheses. The Joint F-test is a test for no long-run effect i.e. of the hypothesis that both coefficients of HP_t and HP_{t-1} are zero at the same time. One star means significance at 5% level, two stars at 1% level and three stars at 0.1% level.

Table 7: Splitting the $FDI50$ spillovers

	(1)	(2)	(3)	(4)	(5)
$HP_t\|_{I-FDI50}$	0.102^{***} (6.01)	0.137^{***} (7.54)	0.026^{**} (2.52)	0.134^{***} (7.40)	0.036^{***} (3.52)
$HP_{t-1}\|_{I-FDI50}$	0.040^{*} (2.31)	0.076^{***} (4.65)	0.012 (1.24)	0.077^{***} (4.66)	0.032^{**} (2.69)
$HP_t\|_{D-FDI50}$	0.246^{***} (10.29)	0.215^{***} (9.56	0.058^{***} (4.66)	0.209^{***} (9.08)	0.054^{***} (4.37)
$HP_{t-1}\|_{D-FDI50}$	0.260^{***} (11.02	0.147^{***} (6.85	0.013 (1.11)	0.125^{***} (5.58)	-0.010 (-0.87)
Year	no	yes	yes	yes	yes
Year $\times$ industry	no	no	no	yes	yes
Year $\times$ country	no	no	yes	no	yes
Obs.	1,508,277	1,508,277	1,508,277	1,508,277	1,508,277
R-squared	2.0%	5.4%	22.6%	7.2%	24.0%
Joint F-Test 1 p-value	36.72 0.000^{***}	75.06 0.000^{***}	7.603 0.006^{***}	71.04 0.000^{***}	20.55 0.000^{***}
Joint F-Test 2 p-value	199.0 0.000^{***}	125.7 0.000^{***}	17.03 0.000^{***}	101.8 0.000^{***}	6.428 0.011^{*}

Note: t statistics in parentheses. Joint F-test 1 is a test for no long run effect for I-$FDI50$, while Joint F-test 2 is a test for no long run effect for D-$FDI50$. One star means significance at 5% level, two stars at 1% level and three stars at 0.1% level.

Table 8: Quantile regressions with $FDI50$

	Whole Sample			**East**	West	**East**	West	**East**	West
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	25%	50%	75%	25%		50%		75%	
HP_t	0.036^{***} (42.70)	0.038^{***} (103.2)	0.037^{***} (40.70)	0.057^{***} (18.87)	0.027^{***} (30.80)	0.051^{***} (38.15)	0.033^{***} (85.74)	0.049^{***} (17.07)	0.032 (33.19)
HP_{t-1}	0.019^{***} (22.81))	0.015^{***} (41.90)	0.11^{***} (13.28)	0.0273^{***} (8.804))	0.005^{***} (5.843)	0.0328^{***} (23.45)	0.000^{***} (0.221)	0.0260^{***} (8.70)	0.0008^{***} (0.81)
Year	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year × industry	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year × country	yes	yes	yes	yes	yes	yes	yes	yes	yes
Obs.	1,508,277	1,508,277	1,508,277	324,412	1,183,865	324,412	1,183,865	324,412	1,183,865

Note: t statistics in parentheses. One star means significance at 5% level, two stars at 1% level and three stars at 0.1% level.

Appendix Tables

9. Statistical appendix

9.1 List of variables used in tfp estimations and regressions and sample delimitations

Table 9.1 Variables

Variable	*Definition*
y(log of output)	Operating revenue deflated by the producer price index (PPI). We have used PPI at 2-digit NACE level. Sources: OPRE from Amadeus, Orbis; PPI from EUROSTAT. NACE revision 1 has been used for all countries but Romania. Coverage: 2001-2008
k(log of output)	Tangible fixed assets deflated by a price index for capital. Sources: TFAS from Amadeus, Orbis; price index for gross fixed capital formation is the average from five capital producing sectors from EUROSTAT. Coverage: 2001-2008
l(log of labour)	Number of employees Sources: EMPL from Amadeus, Orbis. Coverage: 2001-2008
m(log of materials)	Expenditures in intermediate inputs deflated by the producer price index (PPI). We have used PPI at 2 digit NACE level. Sources: MATE from Amadeus, Orbis; PPI from EUROSTAT. Coverage: 2001-2008
FDI10	A dummy equal to 1 if 10% direct single foreign ownership and 0 otherwise. Sources: Amadeus Coverage: 2001-2008
FDI50	A dummy equal to 1 if 50% ultimate ownership or 50% direct ownership and 0 otherwise. Sources: Amadeus Coverage: 2001-2008
MNE50	A dummy equal to 1 if the company belongs to the country in question but ultimately owns at least 50% of affiliates in other countries and 0 otherwise. Sources: Amadeus Coverage: 2001-2008
MNC	A dummy equal to 1 if the company is either FDI50 or MNE50 and 0 otherwise. Sources: Amadeus Coverage: 2001-2008
Herfindahl	Calculated as the sum of the squared market shares in a given 3 digit industry. Sources: Based on OPRe from Amadeus, Orbis. Coverage: 2001-2008
Horizontal penetration (HP3)	Calculated as the share of sales of foreign firms in a given 3 digit industry. Sources: Amadeus Coverage: 2001-2008

9.2 Some details from our preparatory work
9.2.1 Our treatment of missing observations

Table 9.2.1.1 Retrieving and interpolation of economic activity variables in manufacturing sector

	OPRE	EMPL	TFAS	MATE	Total obs.
Observations from AMADEUS DVD	**4,525,518**	**3,993,344**	**5,328,883**	**3,285,210**	**9,742,272**
Observations filled in from previous versions of AMADEUS DVDs	757,418	532,718	770,989	508,272	939,713
Total after addition of observations from previous versions of AMADEUS DVDs	5,282,936	4,526,062	6,099,872	3,793,482	10,681,985
Obs. with missing ownership information deleted	99,931	92,034	108,650	60,892	150,951
Total after missing ownership deleted	5,183,005	4,434,028	5,991,222	3,732,590	10,531,034
Deleting inactive and non-manufacturing firms	258,730	195,396	376,857	184,140	888,405
Total after inactive and nonmanufacturing firms are deleted	4,924,275	4,238,632	5,614,365	3,548,450	9,642,629
Obs. set to missing due to consolidated data	10,823	7,536	9,044	7,321	-
Obs. before filling in Orbis Data	4,913,452	4,231,096	5,605,321	3,541,129	9,642,629
Obs. filled in to substitute for consolidated data using Orbis	7,142	7,466	8,103	3,799	-
Total at this raw stage	**4,920,594**	**4,238,562**	**5,613,424**	**3,544,928**	**9,642,629**
Deleting sector 16	-	-	-	-	4,538
Deleting NACE revision 2 non-manufacturing firms from Romania	-	-	-	-	10,728
Total after deleting sector 16	4,909,017	4,230,206	5,600,015	3,534,187	9,627,363
Obs. for countries without material costs or PPI	825,452	761,114	1,313,813	156,137	2,483,785
Total after dropping countries without material costs or PPI	4,083,565	3,469,092	4,286,202	3,378,050	7,143,578
Setting activity data equal to zero or negative to missing	35,814	7,135	510,721	106,521	35,814
Total after setting activity data equal to zero or negative to missing	4,047,751	3,461,957	3,775,481	3,271,529	7,143,578
Observations filled in when single years are missing	79,124	139,889	55,390	58,963	-
Total after filling in when single years are missing	4,126,875	3,601,846	3,830,871	3,330,492	7,143,578
Obs. deleted if still missing activity data	1,664,093	1,139,064	1,368,089	867,710	4,680,796
Total after obs. still missing activity data deleted	2,462,782	2,462,782	2,462,782	2,462,782	2,462,782
Obs. deleted as outliers	119,287	119,287	119,287	119,287	119,287
Total obs. before tfp estimations	**2,343,495**	**2,343,495**	**2,343,495**	**2,343,495**	**2,343,495**

Table 9.2.1.2. Retrieving and interpolation of ownership variables

Stage	Tot. obs	Total Filled Forward	Zeros Filled Forward	Ones Filled Forward
Raw Stage	9,642,629	124,790 (1.29%)	106,540 (1.10%)	18,250 (0.19%)
After Cleaning/ Before TFP estimation	2,343,495	38,073 (1.62%)	31,227 (1.33%)	6,846 (0.29%)
In regression dataset	1.508.277	19,981 (1.32%)	19.981 (1.32%)	0

Table 9.2.3.1. Loss of observations and industries-country combinations with less than 100 observations available to form a sample for the TFP estimation

Definition of Foreign	Number of domestic obs. after cleaning	Number of industry-country combinations deleted (out of)	Obs. deleted	Number of domestic obs. for TFP estimation
FDI10	2,307,753	52 (420)	2501	2,305,252
FDI50	2,278,020	54 (420)	2349	2,275,671
Foreign*	2,250,817	56 (418)	2393	2,248,424
Pure FDI10	2,337,549	47 (421)	2122	2,335,427
I-FDI50	2,307,346	51 (420)	2380	2,304,966

*Foreign firms are given by FDI10∪FDI50∪MNE50

Table 9.2.3.2.a Loss of observations and industries-country combinations due to negative coefficients in the production function estimates - For different definitions of domestic

Definition of foreign	Neg. coeff. of labor		Neg. coeff. of capital		Neg. coeff. of material		Total obs. deleted	Total number of industry-country combinations deleted
	Number of obs.	Number of industry-country combinations	Number of Obs.	Number of industry-country combinations	Number of Obs.	Number of industry-country combinations		
FDI10	14,159	15	61,579	41	1,661	4	76,199	56
FDI50	40,671	13	60,420	40	12,541	3	100,845	52

Sample as in table 4

Table 9.2.3.2.b Loss of observations and industries-country combinations due to negative coefficients in the production function estimates - For different definitions of domestic

Definition of foreign	Neg. coeff. of labor		Neg. coeff. of capital		Neg. coeff. of material		Total obs. deleted	Total number of industry-country combinations deleted
	Number of obs.	Number of industry-country combinations	Number of Obs.	Number of industry-country combinations	Number of Obs.	Number of industry-country combinations		
FDI10	38,982	13	58,736	43	2,308	4	97,867	55
FDI50	40,250	16	58,079	39	12,682	5	97,885	54
Foreign*	41,468	15	58,381	41	322	2	98,434	54
Deleting betas from all three at the same time	42,327	20	62,096	49	14,763	8	105,341	69

Sample as in table 5-6

*Foreign firms are given by FDI10∪FDI50∪MNE50