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Abstract

When searching for productivity spillovers from foreign firms, a firm is typically classified as foreign using a low threshold of direct foreign ownership. Instead, we advocate an 'ultimate owner' definition because (i) ultimate ownership includes indirect ownership links that are prevalent in our complex, interdependent world; and (ii) it confers control. Control brings greater willingness to transfer knowledge to foreign affiliates but, paradoxically, also greater potential for spillovers. Adopting this alternate definition of what is foreign turns out to be pivotal for identifying spillovers: while we find no horizontal productivity effects using the low threshold direct ownership definition, we find positive and significant effects under the ultimate-owner definition. Moreover, we find evidence that indirectly controlled foreign firms exert the most persistent horizontal spillovers to domestic firms.

JEL-Codes: F210.

Keywords: foreign direct investment, direct vs. ultimate owner, indirect ownership links, control vs. influence, productivity spillovers.

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1. Introduction

The means by which firms secure productivity improvements is central to a number of research streams, not least strategic management and international business (Bertrand and Capron, 2015; Li, Zhu and Zajac, 2009; Zhang, Li, Li and Zhu, 2010). A question of enduring interest is to what extent the presence of foreign firms can create positive 'spillovers' that boost the productivity of domestic firms. Domestic firms may, for example, imitate and learn from foreign entrants with advanced technology or managerial practices, benefit by hiring employees trained by the foreign firm, or respond to the increased competition pressure of the foreign entrant by innovation and operational efficiencies. Foreign entrants try to limit such positive spillovers to their competitors, while governments worldwide remain keen to attract and facilitate foreign direct investment (FDI), in part to secure positive spillovers to domestic firms (UNCTAD, 2017).

Measuring productivity spillover effects 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, Pereira and Slaughter, 2007; Zhang, Li, Li and Zjou, 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; Javorcik and Spartenau, 2008; Girma, Gong, Görg and Lancheros, 2015; Lu, Tao and Zhu, 2017).

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? Further, how might different definitions of FDI affect the extent to which we can find 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. That is, this definition is based on the foreign investor's *influence* in decision making. Whether the investor is 'foreign' is determined simply in terms of residency address. In contrast, we argue that *control* – based on more than fifty per cent (50%) ownership of an affiliate, or 'ultimate ownership' – is more relevant than influence for generating FDI-induced productivity spillovers. Ownership confers both the rights of control over how assets

will be used, and rights to the residual income from the asset (Grossman and Hart, 1986; Hart, 1995, 2017). 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. However, control also has a downside: it potentially damages motivation and creates disincentives for the foreign affiliate who (without control) undertakes productive activities, increasing the likelihood that the advantages transferred by the MNE to its foreign affiliate will diffuse to domestic firms. If control does matter in this seemingly paradoxical 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 globalizing 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. 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 characterized 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 dataset with information about the ownership structure of firms. Data constraints and old assumptions 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 $575,000$ manufacturing firms over 2001-2008, and pay careful attention to how firms are categorized. 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 owner definition (i.e. control-based). Unlike prior studies, we further distinguish between firms controlled through only indirect ownership links and controlled firms with at least 10% direct ownership links. We also separate domestic MNEs from 'pure' domestic firms. Our empirical strategy involves estimating total factor productivity (TFP) using the ACF semi-parametric GMM method (see Ackerman, Caves and Frazer, 2006, 2015) and examining how domestic firms' TFP is affected by the presence of foreign firms, when 'foreign' is defined in two different ways. This method is careful in dealing with the so-called simultaneity problem that arises when production inputs are chosen by the firm's manager who knows well the firm's productivity.

Our findings are somewhat 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 high 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. 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. Yet in prior studies they are included in the domestic firm dataset. 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 findings from prior studies. In contrast, when we run regressions using the ultimate owner definition of foreign firms, we find positive and robust spillover effects. Moreover, these effects seem to be even stronger when we consider only the indirectly controlled firms. Overall, taking into account the importance of control and the complexities of MNE ownership linkages has a significant impact on identifying positive horizontal spillover effects.

We present our study in four sections. The next section maps the historical development of what is 'foreign direct investment', reviews the spillover literature and surfaces fundamental assumptions within it, and presents the theoretical motivation for our preferred definition of a 'foreign firm'. We then describe our data and methods, followed by our results and supplementary analyses. We conclude with a discussion of our main findings and limitations, and point to the implications of our alternate assumption ground and findings for other core areas of strategy research.

2. Theoretical and empirical background

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 (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 organized 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 is 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 interchangeably 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 foreign 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) definition. 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. National statistics often do not capture the full IMF definition of FDI, with the identification of indirect ownership links proving particularly problematic. According to the 2001 update of the joint IMF/OECD Survey of Implementation of Methodological Standards for Direct Investment, only 11 of 61 countries fully applied the standards for recording inward FDI, and 12 for outward FDI (IMF and OECD 2003).[1]

[1] More recent metadata of national FDI statistics continues to show variation across and within 3 main standards, application of no recognized standard, or non-reporting of methods used (see, for example, the online Coordinated Direct Investment Survey cross-economy metadata comparison of the IMF of 118 countries `http://data.imf.org/regular.aspx?key=60559739`; or OECD metadata identifying methods used to determine FDI relationships for 34 countries `https://qdd.oecd.org/data/FDI_Metadata_ComparativeTables/C_Q11+C_Q11_COMM+C_Q11_EXC`. Both accessed 7 May 2018).

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 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. This 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

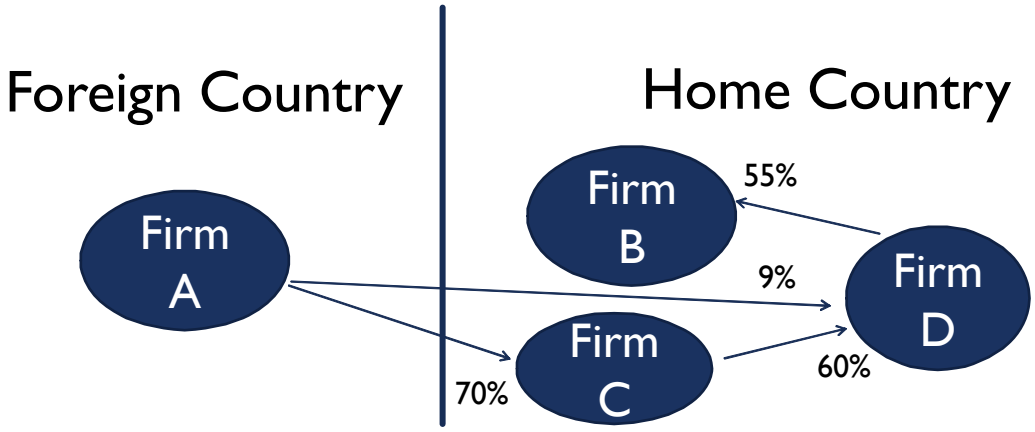


Figure 1 depicts two countries, 'home' and 'foreign'. In the home country firms B, C and D are connected through ownership links. Firm A in the foreign country has direct ownership to two of the three firms in the home country. It is easy to see that firm A controls directly firm C by owning more than 50% of its shares. Thus, firm C will be categorized 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 categorized as domestic because the direct ownership links used in FDI10 show an owner with a domestic address. 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 our 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. The report documents that around 55% of foreign affiliates are not directly owned by their ultimate owner. 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% foreign ownership threshold 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 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 entrants are typically more productive than their domestic competitors in the host country (Helpman, Melitz and Yeaple, 2004). 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 effects; see Balsvik, 2011; Poole, 2013), and in this way improve their productivity (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 research based largely on cross-sectional datasets generally found positive horizontal spillovers (e.g. Caves (1974) for Canada and Australia; Blömstrom and Persson (1983) for Mexico).

Subsequent studies using panel datasets and controlling for industry fixed effects found negative or no effects in developing countries (e.g. Aitken and Harrison (1999) for Venezuela; Haddad and Harrison (1993) for Morocco; Blalock and Gertler (2008) for Indonesia), and positive effects in developed countries (e.g. Keller and Yeaple (2009) for U.S.; Haskel, Pereira and Slaughter (2007) for U.K.), or even mixed results (e.g. Castellani and Zanfei (2003) for Italy, Spain and France). Conflicting results were attributed to great variability in empirical specifications and measures used for productivity (Sjöholm, 1999; Smeets, 2008), and to 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. Especially with backward linkages, i.e. contracts between the MNE and local suppliers, the MNE has an incentive to improve the performance of the intermediate input suppliers.[2] Vertical backward spillovers are more pronounced when the venture is owned jointly by domestic and foreign entities (Havranek and Irsova, 2011; Javorcik, 2004; Newman, Rand, Talbot and Tarp, 2015). Javorcik (2004) argued that such ventures are more likely to source locally than wholly foreign owned entities, leading to greater spillovers. Such actions may also enhance government and public perceptions that the foreign MNE is committed to the economic and social needs of the host country, thereby building the legitimacy and survival prospects of the foreign affiliate (Kostova and Zaheer, 1999; Luo, 2001; Stevens, Xie and Peng, 2016). In short, knowledge transfer through buyer-supplier linkages helps ameliorate some of the challenges of foreign market entry facing the MNE and boosts the productivity of domestic firms. In contrast, 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. Hence the negative competition effect on horizontal productivity spillovers is generally expected to outweigh any positive effects arising from unintended knowledge transfer (Aitken and Harrison, 1999).

Since then, the literature on horizontal spillovers has tried to identify under what conditions positive effects might exist. Explanations have considered the absorptive capacity and motivation of domestic firms (Meyer and Sinani, 2009), the distance and diversity of FDI country origins (Javorcik and Spatareanu, 2008; Zhang, Li, Li and Zhou, 2010), the impact of time or

[2] Productivity improvements for domestic firms 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 and thereby improve their productivity.

entry tenure on spillover effects (Altomonte and Pennings 2008; Kosová, 2010; Liu, 2008; Zhang, Li and Li, 2014), and levels of foreign ownership in terms of majority or fully foreign owned (Javorcik and Spartenau, 2011). The general, albeit not unequivocal, pattern that emerges is one where horizontal spillovers are absent or even negative. This result also holds when one tries to identify the causal effect that FDI has on domestic firms (see e.g. Lu, Tao and Zhu, 2017).

As mentioned in the introduction, we take a step back and question how we define firms as domestic or foreign in our globalized economy. In that respect, we surface and question fundamental assumptions in the extant literature. Existent studies show great variability in definitions used with seemingly no common standard, other than the consistent use of direct ownership links across virtually all studies.[3] For example, Caves (1974) used 50% (single source country) and 25% (single foreign interest) thresholds for Australia in accord with the IMF definition at the time, and a 50% threshold for Canada. 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, Tao and Zhou (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, Javorcik and Spatareanu (2008) and Altomonte and Pennings (2009) considered a firm as foreign if more than 10% of its shares directly belong to an MNE, and domestic otherwise. Similarly, in a sample of firms in China, Girma, Gong, Görg and Lancheros (2015) deem a firm to have foreign ownership if foreign investment accounts for at least 10% of the firm's capital. 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, Li, Li and Zhou (2010) define foreign firms as 100% foreign-owned and domestic firms as 100% domestic owned.

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

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

markets). Any search for 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, Driffield and Higón (2008) resort to defining a foreign firm using the IMF-based minimum direct investment threshold. In contrast, Castellani and Zanfei (2003) and Smeets and de Vaal (2016) do distinguish foreign from domestic firms by using the ultimate owner definition. We go beyond these studies by theorizing *why* ultimate ownership is more relevant in the search for productivity spillovers, and by showing the effects of using different definitions of 'what is foreign firm' using the same dataset and the same methods.

2.3. Ultimate Ownership, Control and Expected Horizontal Spillovers. Our expectation is that positive horizontal productivity spillovers are more likely to be found when using an ultimate owner definition to identify the presence of foreign firms in a domestic economy, than with the commonly used low threshold of 10% direct foreign ownership. We advance two main reasons. The first draws on the literatures of international strategic management (e.g. Bartlett and Ghoshal, 1989; Rugman and Verbeke 2001; Zaheer, 1995) and property rights theory (Grossman and Hart, 1986; Hart 2017) to theorize how ultimate ownership – and the control that comes with it – matters in a somewhat paradoxical way. The second is an empirical measurement issue.

Foreign entrants are typically faced with a 'liability of foreignness' – the additional costs incurred in the foreign market above those experienced by domestic firms (Hymer 1960; Helpman, Melitz and Yeaple, 2004; Zhou and Guillen, 2016). This is likely to be especially acute when competing directly with domestic firms (Zaheer 1995). Competitor local firms have little incentive to share location-specific networks, knowledge or other resources that may reduce the foreign entrants' liability of foreignness. This implies a strong need for the parent MNE to transfer firm-specific advantages (i.e. strengths relative to domestic rivals) to its foreign affiliate that, at the very least, compensate for this liability of foreignness. Such advantages might include superior management and governance practices, advanced production technologies and related know-how, or novel intellectual properties that are non-location bound (Reus, Lamont and Ellis, 2016), and are available through the MNE network but not readily available locally (Bartlett and Ghoshal, 1989; Rugman and Verbeke, 2001; Verbeke and Yuan, 2010; Zaheer, 1995). At the same time, there are powerful incentives for the MNE to prevent domestic competitor firms acquiring its firm-specific advantages (Smeets and da Vaal, 2016). The desire of MNEs to keep such leakage to a minimum is reflected in trends such as the unabated growth

in global intellectual property filings since 2010 (WIPO 2017); robust empirical evidence that MNEs are more likely to transfer technology to their foreign affiliates where strong intellectual property rights exist (Branstetter, Fisman and Foley, 2006); and continuing low levels of R&D internationalization by many MNCs (Berry, 2014; Laurens, LeBas, Schoen, Villard and Laredo, 2015).

We theorize that the MNE is more likely to transfer high levels of valuable knowledge, technology and practices 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 (Grossman and Hart 1986; Hart 1995, 2017; Hart and Moore, 1990).[4] The ultimate owner can occupy the majority on the board of directors and appoint high-level managers to effectively implement key decisions over core business activity of the foreign affiliate (Li, Zhu and Zajac, 2009). In so doing, the ultimate owner can decide on matters such as strategic goals, new investments in plant and equipment, branding and marketing strategy, selection of key suppliers, the strategic use of firm-based or legal mechanisms to protect its proprietary knowledge, and incentives or sanctions to retain human capital with critical knowledge and discourage opportunistic behavior.[5] Ownership also confers rights to the residual income from the assets of the foreign affiliate (Hart, 1995, 2017) and the possibility to engage in organizational practices to maximize this residual, such as transfer pricing or profit shifting (Sugathan and George, 2015). Control through ultimate ownership thereby gives a sense of security that encourages the parent to exchange knowledge and technology with its foreign affiliate at a much higher level than any pair of firms with no controlled relationship.

Empirical evidence supports our view.[6] Using royalty payments to parents as an indicator of technology transfer, Desai, Foley and Hines (2004) find evidence that majority and wholly owned subsidiaries of U.S. MNEs receive more intangible property from their parent companies than do minority owned affiliates. They also find that companies operating in research-intensive industries are the most likely to establish wholly owned subsidiaries, and attribute this to the

[4] International joint venture arrangements may, for example, include contractual agreements that assign control over specific resources or activities across partners (Mjoen and Tallman, 1997). The right to decide about things missing in the contract is called the residual control or decision right (Hart, 2017).

[5] Flitotchev, Stephan and Jindra (2009) find that majority foreign ownership positively correlates with their proxies for decision-making control in the areas of strategic management and planning, marketing and operational management in their study of five Eastern European counties.

[6] Empirical evidence is, of course, based on direct ownership linkages.

higher perceived risks of technology appropriation under partial ownership. Nachum (2010) finds that majority owned affiliates of foreign MNEs in London's financial sector have significantly more advantages than minority-owned affiliates, and interprets this as reflecting the greater benefits that accrue to majority owned affiliates from the advantages of their parents. Zhang, Li, Hitt and Cui (2007) and Zhang, Li and Li (2014) similarly suggest that a foreign partner in an international joint venture is more likely to contribute its technologies and skills if it has majority ownership.

Control does not mean, however, that productivity spillovers – arising from, for example, demonstration effects or labour market impacts – are fully prevented by the ultimate owner. Contracts between joint investors are inevitably incomplete: writing a contract specifying all aspects of the rights to use intangible assets is difficult, or even impossible (Hart, 2017). Minority domestic partners in the affiliate can, for example, gain access to some new knowledge or technology that they then build into their own practices in ventures other than the jointly owned affiliate, and may share it with other domestic firms (Javorcik and Spartenau, 2008).

Moreso, even wholly owned subsidiaries may generate undesirable (from the ultimate owner's perspective) spillovers to domestic firms. As Grossman and Hart (1986 p. 693) observed, "[t]o the extent that there are benefits of control, there will always be potential costs associated with removing control (i.e. ownership) from those who manage productive activities." While possession of control rights gives the ultimate owner an incentive to make affiliate-specific investments, the foreign affiliate's incentive to make firm-specific investments is weakened with the presence of an ultimate owner. Having fewer residual control rights, the foreign affiliate will most likely receive a smaller fraction of the surplus created by its own investments than if in a non-controlled relationship (Hart, 1995). Top management of the subsidiary thus has less stake in the outcome of any investment (Chen, 1996). As a result, under-investments may manifest in, for example, insufficient safeguarding of the knowledge and technologies transferred by the ultimate owner (McGaughey, 2002), or by not developing the human or social capital needed to fully harness the firm-specific advantages contributed by the ultimate owner (Foss, Foss and Nell, 2012). In contrast, when a firm receives less than 50% investment it is likely to retain more residual control rights and a greater proportion of the income created by any complementary or relationship-specific investments that it makes. This creates a strong incentive to effectively safeguard the (albeit smaller) advantages provided by the foreign investor, engage in further firm-specific investments, and attempt to limit spillovers to other domestic firms.

Further, the ability of the ultimate owner to effectively make key decisions over core business activity of its controlled foreign affiliate may itself be at times counter-productive. In the context of MNE headquarters, Foss and colleagues argue that delegation of discretion or decision rights to subsidiary managers may strengthen autonomous motivation, creativity in the pursuit of goals, and the discovery, creation, sharing and integration of new knowledge. However, when the MNE headquarters engages in managerial interventions (e.g. overruling decisions previously made by the foreign affiliate) even if for entirely benevolent reasons, the intervention may be perceived as ill-intentioned by the affiliate's managers and employees. Such "intervention hazards" (Foss, Foss and Nell, 2012, p. 248) can thereby have a de-motivating effect and result in imperfect effort by subsidiary managers and employees when making and safeguarding firm-specific investments. Managers and workers within subsidiaries can choose to withhold effort or behavior the owner seeks, to engage in unfavorable behaviors, or even to leave the firm (Hart, 1995; Wright and McMahon, 2011).

In short, control through ultimate ownership is somewhat paradoxical. On the one hand, control provides the incentives needed for the ultimate owner to transfer valuable knowledge, technologies and human capital to the foreign affiliate – a necessary, but not sufficient, condition for productivity spillovers to occur. On the other hand, contracts are always incomplete. Further, control creates a context in which managers and workers in the foreign affiliate may be less motivated to make and safeguard firm-specific investments. Control through ultimate ownership thus creates the potential for positive spillovers in a way that a low threshold of foreign investment cannot. If control does matter in this way, then we expect that the possible positive 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, and related, is an empirical issue of misclassification. Definitions that use only direct ownership linkages to define a firm as 'foreign' lead to foreign affiliates ultimately owned through indirect linkages being included in the domestic firm data set. This is not of an insignificant magnitude: as previously noted, more than 30% of foreign affiliates are indirectly owned through a domestic entity (UNCTAD 2016). If foreign affiliates are on average more productive than domestic firms (Helpman, Melitz and Yeaple, 2004), this incorrect categorization will upward bias the estimated productivity of domestic firms, and downward bias the estimated productivity and presence 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. In this sense, previous studies that use the direct ownership linkages, irrespective of what threshold is applied, have perhaps stacked the cards against finding positive spillover effects from the presence of foreign firms!

3. Data

Our dataset is drawn from the ORBIS database owned by Bureau Van Dijk and used by the 2016 World Investment Report. 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.[7] We acquire DVDs with single releases of the data for the 1996 to 2010 period. Appendix 1 describes the details of how we cleaned and prepared the dataset. We are able to create a consistent unbalanced firm-level panel dataset for approximately $575,000$ manufacturing firms ($2,343,495$ observations) between $2001-2008$ with full ownership and financial data, across 20 European countries.

The invaluable advantage of the ORBIS dataset is that it provides the global ultimate ownership (GUO) variable that we need here. 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 (UNSTAD 2016) and thus requires one to distinguish between voting and non-voting shares when considering ownership. The ORBIS database tracks control voting rights 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 categorizes an ultimate owner based on having a voting control at 50.01% or higher.[8]

We define the following firm sets:

- FDI10: firms where a single foreign owner directly owns more than 10% of shares.
- FDI50: firms where a single foreign owner ultimately controls more than 50% of voting shares.

[7] We work with the detailed ORBIS/Amadeus version where all firms with 5 or more employees are included. For a detail account of ORBIS/Amadues and how representative it is compared to the Eurostat data, see Kalemli-Ozcan, Sorensen, Villegas-Sanchez, Volosovych and Yesiltas (2015).

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

- I-FDI50: firms that are FDI50 but not FDI10. These are firms that would be classified as domestic under the 10% definition, but foreign under the ultimately owned definition.
- D-FDI50: firms that are both FDI50 and FDI10. These are firms that would be classified as foreign under both the 10% definition and the ultimately owned definition.
- MNE50: firms which ultimately control subsidiaries in other countries and are not FDI50.
- Pure domestic: firms that are neither FDI10 nor FDI50 nor MNE50.

Note that according to UNCTAD (2016, p.147) about one per cent of foreign affiliates are owned by a domestic entity through 'round tripping'. Round tripping occurs when an affiliate (e.g. in Germany) has a foreign direct owner (e.g. in France) and a domestic ultimate owner (in Germany).[9] In studies overlooking indirect ownership links, the affiliate will be treated as foreign, by virtue of its direct investor in France. In our study, we recognize the affiliate in Germany as a domestic affiliate of the German ultimate owner. The affiliate is thus part of a domestic MNE, and we exclude it from the set of 'pure' domestic firms.

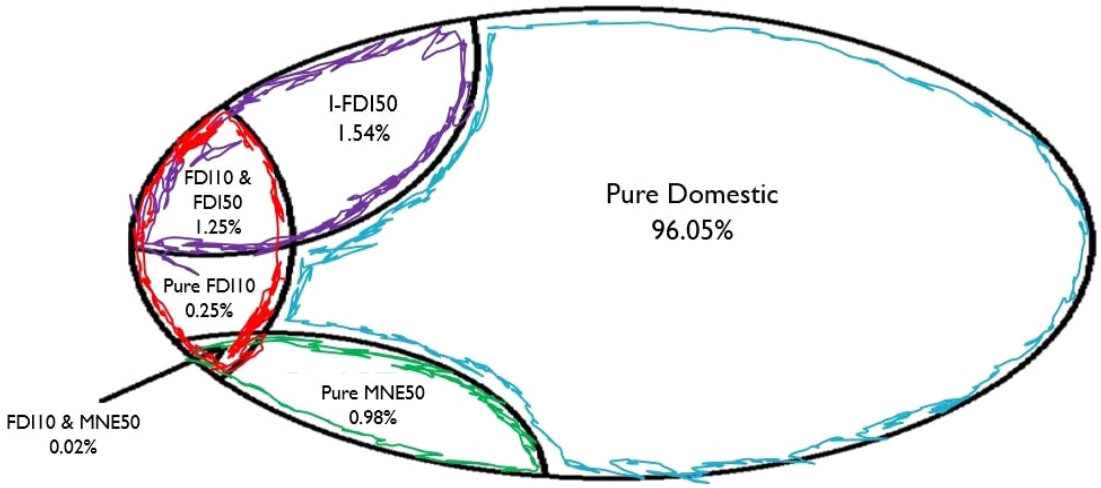
Figure 2 below – the "egg" – illustrates the distribution of our ownership data according to the above definitions. This is based on a total of $2,343,495$ observations (firms-years), which corresponds to roughly $575,000$ firms.[10] As seen, the large majority of the observations are purely domestic 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). By definition an observation cannot be FDI50 and MNE50 at the same time. Note that firms can have both a single foreign shareholder owing at least 10% of the votes and be controlled ultimately by a single foreign firm. Hence, when focusing on the standard IMF-based definition of 'foreign' (FDI10) used in spillover studies we see an overlap with our FDI50 definition. The overlap with MNE50 is negligible as very few domestic MNEs have a single foreign shareholder

[9] Round-tripping can arise for a variety of reasons. For example, it may result when an MNE acquires or merges with another MNE based overseas that already owns affiliates in the home country of the acquirer, or where MNEs deploy ownership structures organized by divisions, with a divisional headquarters based outside the home country owning companies in its line of business within the home country (UNCTAD 2016, p. 148). It can also arise when an MNE uses offshore locations (e.g. tax havens) to channel investments back to their home country, or to overcome specific domestic financial market imperfections or institutional constraints (see Buckley, Sutherland, Voss and El-Gohari, 2013).

[10] 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 split 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'.

owning more than 10% of its equity. Note that the indirectly owned foreign firms (I-FDI50) are just as many as the FDI10 firms.

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 shown in Table 1 below.[11]

Table 1: around here

Table 1 shows that pure domestic firms are on average considerably smaller and less productive than foreign firms. It also shows that FDI10 firms seem to be smaller than other foreign firms. In particular, the FDI50 firms are larger and more productive (in terms of labour productivity; TFP will be derived later). 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.[12] The most productive firms of all are the indirectly owned foreign firms (I-FDI50). These are the firms that studies using the direct-ownership definition will not capture as foreign and thus will be considered as domestic.

[11] 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 revenues over number of employees from the firm-level data and not as the ratio of columns 3 and 4.

[12] As we will see, the same result holds when calculating total factor productivity for the different firm categories.

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, I-FDI50 firms are spread throughout Europe, although the representation of these firms is higher in 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).

4. Empirical strategy

We follow the literature in running FDI productivity spillover regressions using a 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 preferred definition of what is foreign. In doing so, we pay careful attention to whether it is this change of what is 'foreign' that explains our results, or the particular data set and empirical methods used.

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:

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

Horizontal presence (HP) is defined as the share of revenues 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.[13] 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. 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

[13] The use of revenues is sometimes in the literature substituted by employment levels. We have used both measures and found a correlation of 0.94 between an HP-revenues and an HP-employment index. We have also rerun all our regressions using an employment-based HP variable and we get the same qualitative results. In what follows we use the HP-revenues index. Note also that the use of share of revenues as a measure of foreign presence overcomes some of the criticisms levelled at studies that look simply at stocks or flows of FDI, rather than activity-based measures (see Beugelsdijk et al. 2010 for discussion).

revenues 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 also focus within the FDI50 set of firms and look more closely at the I-FDI50 firms.

Table 3 below reports the distribution of the HP variable for each of the above definitions. 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% when using the FDI10 definition of 'foreign', it is 15.6% under the FDI50 definition.

Table 3: around here

We now move on to explain how we derive our independent variable, the domestic firms' total factor productivity (TFP). A major econometric issue confronting estimation of productivity is the possibility that there are determinants of productivity that are unobserved to the econometrician, but observed by the firm's managers. In this paper we take into account such issues, and adopt the control function approach developed in Ackerberg, Caves, and Frazer (2006, 2015) and modified by De Loecker (2011), De Loecker and Warzynski (2012), and De Loecker, Goldberg, Khandelwal and Pavcnik (2016). This approach is careful in dealing with the potential endogeneity of inputs problem that arises when calculating the residual of the output minus inputs component of productivity.[14] De Loecker (2011) is the first that modifies the ACF procedure by allowing more variables (than just lagged productivity) to appear in the productivity law-of-motion function, i.e. the function that describes what the firm's manager knows about the firm's productivity (see below for more details on this).

The main equation of the procedure is a revenue-based Cobb-Douglas production function logarithmically transformed:

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

where Y is revenues, L is labour input (number of employees), K is capital input (in value terms), M is material input (in value terms),[15] 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).

[14] This so-called ACF procedure is an extension of the GMM procedures suggested by Olley and Pakes (1996) and Levinshon and Petrin (2003). For yet a different method see Wooldridge (2009).

[15] See Appendix 1 that describes how we collect and prepare our data step by step.

The modified ACF procedure involves a stepwise implementation. The ACF method assumes that labor and capital inputs are decided first as they are difficult to alter in the short-run (compared to 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 function that adds the lagged HP measure to the regressors, i.e. $\omega_{it} = g_t(\omega_{it-1}, HP_{jt-1})$. The intuition for this is that we believe managers know how much foreign horizontal presence exists and take this information into account when employing production inputs. This law-of-motion function allows us 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). The final coefficient estimates of lnL, lnK and lnM from (1) are then estimated using a generalized methods of moments (GMM) estimation technique.

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:

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

where TFP_{ijct} is the total factor productivity of a domestic firm i, in industry j, within country c, at year t. In order to remove any influence from time invariant firm specific variables we estimate equation (2) using firm fixed effects. We note here that domestic firms are defined within their NACE 2-digit industry. To ensure we have variation in the HP variable within these industries, we have defined the presence of foreign firms at the 3-digit industry level.

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.[16] The current specification of equation (2) includes the lagged HP measure and allows for consistency with the Markov 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

[16] We experimented with 2- and 3-year lags, but include here only a 1-year lag as the only lag that was statistically significant.

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 report the result of such an F-test as well.

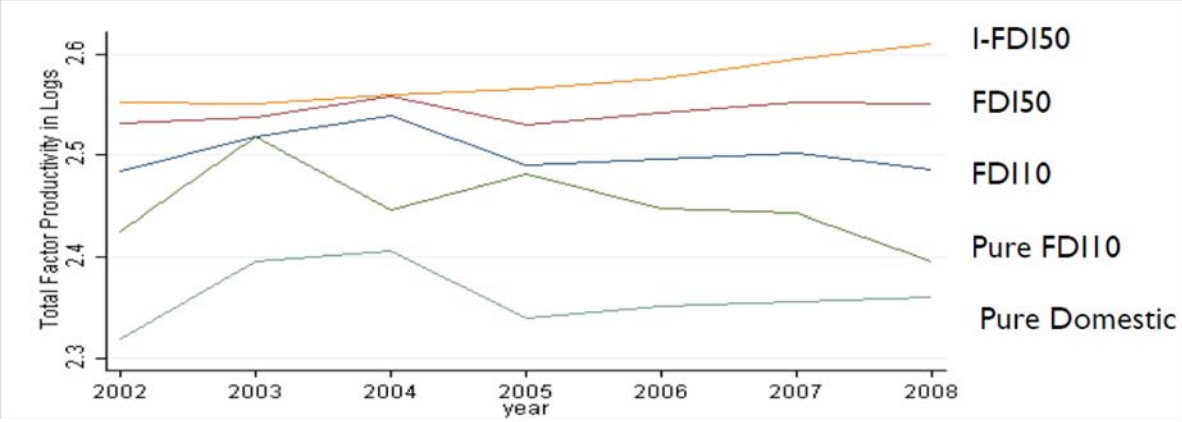
In the specification of (2) we allow for time fixed effects by using the D_t dummy. With 7 years of data it makes sense to allow for different means in TFP for each year in addition to the HP effects. We also include interactive industry-year and country-year fixed effects to absorb any time-varying, industry- and country-level characteristics that may influence the productivity of domestic firms. Including the full set of fixed effects constitutes our most robust regressions.

In the next section we present different estimations of (2) depending of how we define 'foreign'.

5. Results

5.1. TFP Estimations. We start by visualizing in Figure 3 the evolution of the TFP estimates for different firm sets.

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



Note: The TFP calculation here adopts the modified ACF method and we assume that the HP entering the productivity law of motion is defined over all "foreign" firms, i.e. the union of FDI10, FDI50 and MNE50.

As seen above, 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 'pure FDI10' set (the green line) that, through the years, exhibit 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.[17] Finally, the fact that 'pure FDI10' firms are less productive than FDI10 firms is consistent with the control story that we theorized above. 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 now turn.

5.2. Main Regression Results. Our first set of regressions is presented below in Table 4. We start by running spillover regressions with two different definitions of what is 'foreign'; the FDI10 and the FDI50. We define a firm as domestic if it is not foreign (as most in the literature have done). Due to this, the number of domestic firm 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

Without controling for year, industry-year, and country-year 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 possible fixed effects (see column #5) makes the significance of these results disappear. The joint F-test reveals that the sum of the contemporaneous and lagged HP effect is not statistically different from zero.[18] Thus consistent with the literature, when all possible fixed effects are 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 (column #10).

However, because table 4 regressions are done on a different set of domestic firms, it could be that the different results are due to different data sets. Running the same regressions on the same set of domestic firms – the so-called, *pure* domestic firms, which are domestic firms that are not FDI10, FDI50, nor MNE50 – does not change the above results. Table 5 below reports

[17] 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 more or less an equal number of I-FDI50 observations in each of the years.

[18] 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.

these results.

Table 5: around here

As in table 4, the FDI10 regression with all fixed effects included (column #5) shows no statistical significance for the long-run spillover effect to pure domestic firms. In contrast, the FDI50 regression (column #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 FDI50 that matters in managers' production input decisions. As we see in table 6, nothing substantial changes; while the long-run spillovers from the presence of FDI10 foreign firms are still not found, the presence of FDI50 firms exerts a positive and statistically significant productivity effect on pure domestic firms.[19]

Table 6: around here

Table 7 presents the point estimates and confidence intervals around them, lending further support to our interpretation of results. The long-term FDI10 effect is clearly insignificant, with zero included even at the 95% confidence interval. In contrast, the long-term FDI50 effect is clearly significant, with zero excluded at even the 99.9% confidence interval. Having cemented this contrast as one of the main results of our paper, we can now comment on the economic significance of the coefficients derived above.

Table 7: around here

Note that a 1 percentage point increase in the horizontal presence of FDI50 firms (i.e. increasing HP 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

[19] We also performed the same regressions when the HP variable refers to the union of all non-pure domestic firms, i.e. the union of FDI10, FDI50, and MNE50, and the results remained qualitatively the same as reported in Table 6.

then equal $0.17 \times 0.052 \times 100 = 0.90\%$ in TFP.[20] As expected, this number is smaller compared to the number found in the vertical spillover literature. This could be because the vertical spillover literature captures both unintended and intended transfer of knowledge. As noted previously, in buyer-supplier linkages the MNE has an incentive to help improve the performance of the domestic supplier. This is not the case for the intra-industry spillovers to domestic competitors. In this sense, and given the prior consensus of zero or negative horizontal effects, our positive and significant effects are noteworthy.

6. Supplementary analysis

In the above analysis we systematically varied elements of the research design in a series of stages. We first established the spillover effects arising from foreign firm presence using the baseline FDI10 (influence based) definition, and then compared it to our preferred FDI50 (control based) definition. Next we made the domestic firm data set consistent across the two (FDI10 and FDI50) definitions. Finally, we removed variation in the TFP estimates arising from how we define foreign presence in the productivity law-of-motion. That is, we pursued a within-study, quasi-replication strategy (cf. Bettis, Helfat and Shaver 2016) to explore the robustness of our initial results. In what follows we perform extensions to get further insights.

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. To capture this, we calculate the Herfindahl index using our ORBIS data and find that our results do not change – the Herfindahl index variable is simply not statistically significant (we do not report these results here for brevity).

The significant presence of indirectly controlled foreign firms (I-FDI50) prompted us to explore whether they differed from controlled firms with direct ownership links (D-FDI50) in the spillover effects exerted. We start by splitting the FDI50 set of controlled firms into two subsets – those with direct ownership links above 10% (D-FDI50) and those with only indirect

[20] Of course, the above numbers are overall averages and if we looked at particular countries and industries the HP changes may differ substantially. For example, the change in HP for Sweden from 2004 to 2005 in the "Manufacture of electricity distribution and control apparatus" was 0.77, while the change in HP for Norway from 2005 to 2006 in "Manufacture of articles of concrete, plaster and cement" was 0.25 Finally, for Italy from 2006 to 2007 in "Manufacture of vegetable and animal oils and fat" the change in HP was 0.15. Of course, larger changes in HP will lead to larger increases in TFP.

ownership links (I-FDI50) – and re-run our regressions. The results are reported in table 8.[21]

Table 8: around here

We see that the I-FDI50 set has larger and more significant spillover effects on pure domestic firms. In particular, while the long run effect of the indirectly controlled foreign firms ($0.041 + 0.027 = 0.068$) is significant at the 0.1% level, the effect of the D-FDI50 foreign firms ($0.059 - 0.005 = 0.044$) is significant at the 1% level (see column #5, joint F-test 1 and 2). Nonetheless, statistically, we cannot reject that the two coefficients are equal to each other.

However, recall that I-FDI50 firms are on average larger than D-FDI50 firms (see table 1 above). We therefore now try to remove this size difference by comparing spillover effects from similarly sized firms. We begin by using a Wilcoxons test for equal distributions of our two samples, and confirm that the I-FDI50 and D-FDI50 firms indeed have different size distributions. By repeating the Wilcoxons test for several subsamples, we identify a pair of cut-off points – viz. 71-181 employees – where the I-FDI50 and D-FDI50 have statistically the same size distribution. We can now split our previous HP measure into three new measures according to firm size: a HP measure for I-FDI50 firms below 71 employees, one for I-FDI50 firms with between 71 and 181 employees, and one for I-FDI50 firms with above 181 employees. We do the same for the D-FDI50 firms. Results from re-running our regressions with the new HP measures are reported in table 9.

Table 9: around here

The results show no long-run spillover effect from I-FDI50 firms nor D-FDI50 firms below 71 employees in size. For foreign firms with above 181 employees, we do see positive long run spillover effects for both groups of firms (the Joint F-test for I-FDI50 and for D-FDI50 are both significant). However, we cannot reject that these two effects are of the same size (the Joint F-test for equal long-term D-FDI50 & I-FDI50 is not rejected). Most interestingly, for firms with 71-181 employees we see positive spillover effects for the I-FDI50 firms – the Joint F-test for I-FDI50 (7.988) is significant at the 1% level ($p < 0.004$) – but not for the D-FDI50 firms – the Joint F-test for D-FDI50 (0.022) is insignificant with a $p < 0.892$. Moreover, when we test whether these two effects are equal, we reject it at the 5% level. Thus, the moment

[21] Not to be criticized of omitted variable bias, we run our regressions including the presence of all non-pure domestic firms. However, for brevity we only report in our tables the FDI50 firms that are central here.

that we compare subsets of firms with similar size distributions, we only find positive spillover effects from the I-FDI50 firms. Thus, we can tenatively conclude that these foreign firms that previously were categorised as domestic do indeed exert a positive spillover effect to domestic firms that cannot be explained by size alone.

7. Discussion and conclusions

This study contributes to the strategic management field by exploring a potentially important source of firm performance, namely intra-industry productivity spillovers from the presence of foreign firms. Such spillovers to domestic firms are notoriously difficult to identify. Our problematization (Alvesson and Sandberg, 2011) of existing assumptions about what is a foreign firm when looking for FDI-induced productivity spillovers was central to finding more spillovers than previous studies. Notably, our alternative definition of 'what is foreign' is grounded in both the empirical world and in theory.

The 2016 World Investment Report documents how extensive indirect ultimate ownership links have become in our globalizing, interdependent world. We go beyond the report by showing the relative number, size and productivity impact of these ultimately owned and controlled foreign firms compared to directly owned foreign firms at the 10% threshold. The empirical reality we document through a careful categorization of more than 570,000 firms (or 2.3 million observations across seven years) is that there are twice as many foreign firms that are ultimately controlled than what the 10% definition captures.

Our theoretical motivation for advocating attention to 'ultimate ownership' when identifying foreign firms who may exert positive spillovers on the productivity of domestic firms centres on the importance of control. Paradoxically, the very control that fosters greater transfer of MNE advantages to the foreign affiliate may also create an organizational context whereby these advantages are more likely to diffuse to other firms. Ultimate ownership thereby creates the potential for spillovers beyond what is likely with a low threshold of foreign investment. Any study using only direct ownership data to identify 'foreign' firms is bound to underestimate these spillover effects.

Our findings support our theorizing. 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 ultimately owned FDI50 foreign firms has a positive and significant spillover effect. This result holds for the same set of domestic firms and using the same methods of estimating their TFP. 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'. While the ultimately foreign owned firms turn out to be on average larger and more productive than the 10% direct foreign owned firms, the indirectly controlled firms are found to be the most productive of all. Importantly, it is that set of indirectly controlled foreign firms that studies using the direct and low threshold component of the IMF definition would have missed and categorized as domestic firms.

Within the set of controlled firms, we further provide evidence that it is these indirectly controlled foreign firms that exert the most persistent horizontal spillover effects to domestic firms. Having ruled out size as a main driver of these differences, we offer three plausible explanations. First, with direct ownership links comes the potential for direct control through a single link between ultimate owner and the foreign affiliate. With indirect ultimate ownership, however, there are more links in the chain of ownership at which 'knowledge leakage' could occur; more interfaces across which knowledge must travel, and more exchanges where opportunistic behaviour or even benevolent imperfect effort may manifest, leading to external diffusion of the firm-specific advantages being transferred through the MNE network. Second, similarity breeds connection, and knowledge may more readily transfer between 'similar others' (Mäkelä, Andersson and Seppälä, 2012). We might therefore expect greater labour mobility and interactions between domestic firms and indirect ultimate foreign firms that *appear* domestic (or are less obviously foreign), than with controlled firms with direct foreign ownership links. For example, Lamin and Ramos' (2016) fieldwork among research and development (R&D) labs in India found labour mobility was the primary mechanism by which knowledge spillovers to local firms occurred, and that movement tended to occur between domestic firms or between foreign firms, but not across the two groups. Third, the indirectly controlled foreign firms may possess more intangibles, e.g. patents, which are themselves more subject to unintended transfer or diffusion than physical assets (McGaughey, 2012). None of these explanations are mutually exclusive, and each provides avenues for future research.

A limitation of our ultimate ownership variable is that it is not a continuous, or even discrete (e.g. 50%, 75%, 100%), variable. While direct ownership is a continuous variable in ORBIS, ultimate ownership is not. If it was, then one could test whether different levels of ultimate ownership have a differential impact on FDI-induced horizontal spillovers. Generally, we do not think that would be the case. As argued previously, ultimate ownership affords control through voting rights. Li, Zhou and Zajac (2009) argue that once controlling ownership (i.e.

over 50% direct ownership in their study) is reached, higher levels of equity are not likely to generate a correspondingly meaningful increase in the level of control. Hence, we expect that the motivating effect of additional equity on the transfer of advanced knowledge and capabilities by the ultimate owner is relatively weak.

One could also question whether studies on horizontal spillovers are also capturing vertical spillover effects. This is most likely. The NACE industry categories used in most studies, including ours, are at the two- or three-digit level. There could conceivably be buyer-supplier linkages within these broad industry classifications, and more finely grained studies in the future would be invaluable. In the context of our study, however, it was important to pursue an empirical strategy that maximized comparability with prior findings (see Bettis, Helfat and Shaver 2016).

The significant presence of foreign-controlled firms that appear to be domestic by virtue of their indirect ownership links has implications for a number of other fields in strategy. Cross-border mergers and acquisitions (M&A), for example, are of intense interest to strategy scholars (Anand and Delios, 2002; Humphery-Jenner, Sautner and Suchard, 2017; Li, Xia and Lin, 2017). As with the spillover literature, however, studies in this field typically identify direct acquirers for each transaction, and not the ultimate owner of the acquiring firm. Hence, a significant number of acquisitions made by a firm ultimately foreign owned through indirect linkages will not be identified as a crossborder M&A, but as a domestic acquisition. By focussing only on direct transactions, M&A studies likely underestimate the presence of MNEs in the merger or acquisition, and potentially miss important sources of firm heterogeneity that affect performance.

Similarly, research on how MNEs endeavour to overcome a 'liability of foreignness' and build legitimacy in host countries and throughout the MNE network (Kostova & Zaheer, 1999; Li, Xia and Lin, 2017; Regner & Edman, 2016; Stevens et al., 2017) may also be enriched by our problematization of what is a foreign firm. For example, an indirect ownership structure may mask foreign identity and, in turn, alleviate potentially negative or discriminatory assessments of 'foreigness' made by local stakeholders. To what extent control through indirect ownership structures is a deliberate MNE strategy of legitimation, what types of legitimacy it may foster (or impede), and with what consequences is an intriguing line of future inquiry.

Our research has a number of implications for practice. For executives of foreign MNEs, it draws attention to the need to manage the paradoxical influence of control, including unintended consequences in the form of amplified spillovers to domestic competitors in the host country. For

executives of domestic firms, it draws attention to foreign presence that may go unrecognised as such, and related possibilities to acquire the advantages transferred by MNEs if one knows where to look. We anticipate our findings will also be of intense interest to policy makers. National investment policy measures often discriminate – positively or negatively – between domestic and foreign investors. Reasons for such discrimination are varied, but can include concerns, related to national security the social impact of MNEs the use of natural resources and industrial development (UNCTAD, 2016). Our findings highlight the potential for mis-measurement of foreign presence across all these concerns but, most directly, point to the likelihood of under-estimating the extent and source of FDI-induced intra-industry spillovers that boost the productivity of domestic firms. Recognising the source of productivity improvements is central to effective policy for industrial development.

Complex ownership structures in which affiliates are increasingly distant from corporate headquarters are likely to become more common, not less (UNCTAD, 2016). We hope that consideration of the alternate ontology of 'what is a foreign firm' we advocate in the context of horizontal spillovers – i.e. the control-based, ultimate owner definition – will inspire new research questions and theorizing across diverse fields of inquiry. Equally important are quasi-replications of existing studies akin to what Bettis, Helfat and Shaver (2016) advocate. Where the application of an ultimate owner definition is theoretically or empirically meaningful, quasi-replication studies can help assess the robustness and generalisability of prior findings. We encourage research along both lines as we strive to gain a deeper understanding of the phenomena we study in strategic management and international business.

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Table 1: Activity data summary statistics

	Obs.	**Firms**	**Revneues** (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 2: Distribution of foreign firms across countries

Country Code	FDI10	FDI50	I-FDI50	Total Obs.	$\frac{\text{I-FDI50}}{\text{Total obs}}$
Netherlands*	168	377	249	1,227	0.2029
Austria*	372	641	325	2,230	0.1457
Belgium*	2,841	5,299	2,873	20,191	0.1422
Germany*	2,659	5,975	3,754	31,852	0.1178
Slovakia	301	896	611	9,831	0.0621
Poland	2,672	3,692	1,401	29,893	0.0468
Chech	1,845	3,072	1,549	34,233	0.0452
Slovenia	95	395	311	14,674	0.0211
Norway*	759	1,423	763	37,632	0.0202
France*	8,860	17,222	9,894	501,448	0.0197
Hungary	462	654	329	19,454	0.0169
Finland*	751	1,396	741	51,300	0.0144
Bulgaria	247	543	347	28,312	0.0122
Sweden*	934	2,075	1,377	119,380	0.0115
Italy*	4,687	8,760	4,937	445,858	0.0110
Spain*	4,477	8,029	4,348	505,929	0.0085
Romania	2,807	3,435	1,382	238,312	0.0057
Bosnia & Herzegovina	27	71	47	9,786	0.0048
Portugal*	661	849	321	76,435	0.0042
Ukraine	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 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
$HP_{I\text{-}FDI50}$	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.

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)	0.142^{***} (6.76)	0.034^{**} (2.84)	0.030^{*} (2.39)	0.102^{***} (5.30)	0.145^{***} (7.10)	0.151^{***} (7.01)	0.033^{**} (3.21)	0.045^{***} (4.50)
HP_{t-1}	0.232^{***} (11.47)	0.103^{***} (5.36)	0.086^{***} (4.27)	0.019 (1.69)	-0.007 (-0.70)	0.101^{***} (5.09)	0.108^{***} (5.89)	0.112^{***} (5.71)	0.001 (0.15)	0.009 (0.91)
Year	no	yes	yes	yes		no	yes	yes	yes	yes
Year × industry	no	no	yes	no	yes	no	no	yes	no	yes
Year × country	no	no	no	yes	yes	no	no	no	yes	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%	6.8%	22.4%	23.7%	0.3%	5.3%	7.4%	26.2%	27.7%
Joint F-Test	183.0	72.67	58.77	10.82	1.78	48.51	75.75	67.32	4.679	12.97
p-value	0.000^{***}	0.000^{***}	0.000^{***}	0.001^{***}	0.182	0.000^{***}	0.000^{***}	0.000^{***}	0.031^{*}	0.000^{***}

Note: t statistics in parentheses. The Joint F-test is a test for no long-run effect. 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)	0.156^{***} (6.93)	0.038^{**} (2.91)	0.031^{*} (2.27)	0.103^{***} (5.21)	0.148^{***} (7.02)	0.156^{***} (7.00)	0.0327^{**} (3.09)	0.044^{***} (4.50)
HP_{t-1}	0.249^{***} (11.29)	0.120^{***} (5.75)	0.102^{***} (4.66)	0.017 (1.43)	-0.012 (-1.04)	0.104^{***} (5.05)	0.111^{***} (5.86)	0.117^{***} (5.72)	0.0005 (0.05)	0.009 (0.84)
Year	no	yes	yes	yes	yes	no	yes	yes	yes	yes
Year × industry	no	no	yes	no	yes	no	no	yes	no	yes
Year × country	no	no	no	yes	yes	no	no	no	yes	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%	6.7%	22.2%	23.5%	0.3%	5.4%	7.5%	26.4%	27.9%
Joint F-Test p-value	180.3 0.000^{***}	81.46 0.000^{***}	65.30 0.000^{***}	10.04 0.002^{**}	1.037 0.309	47.09 0.000^{***}	74.10 0.000^{***}	67.08 0.000^{***}	3.97 0.040^{*}	12.54 0.000^{***}

Note: t statistics in parentheses. The Joint F-test is a test for no long-run effect. 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)	0.156^{***} (7.28)	0.046^{***} (4.00)	0.039^{***} (3.33)	0.089^{***} (5.05)	0.128^{***} (7.40)	0.132^{***} (7.33)	0.028^{**} (3.09)	0.037^{***} (4.24)
HP_{t-1}	0.231^{***} (11.07)	0.102^{***} (5.19)	0.083^{***} (4.05)	0.005 (0.47)	-0.023^{*} (-2.14)	0.101^{***} (5.37)	0.107^{***} (6.43)	0.106^{***} (6.42)	0.012 (1.28)	0.015 (1.78)
Year	no	yes	yes	yes	yes	no	yes	yes	yes	yes
Year × industry	no	no	yes	no	yes	no	no	yes	no	yes
Year × country	no	no	no	yes	yes	no	no	no	yes	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%	6.9%	22.6%	24.0%	0.3%	4.9%	6.9%	22.6%	24.0%
Joint F-Test p-value	190.3 0.000^{***}	81.42 0.000^{***}	63.25 0.000^{***}	10.28 0.002^{**}	0.937 0.333	48.48 0.000^{***}	86.39 0.000^{***}	81.01 0.000^{***}	8.83 0.003^{**}	17.13 0.000^{***}

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

Table 7: Point estimates and confidence intervals

	Coefficient	SE	$99,9\%$ CI	99% CI	95% CI	t-value
$HP^{t}_{FDI10} + HP^{t-1}_{FDI10}$	0.016	0.016	$-0.038 : 0.070$	$-0.026 : 0.058$	$-0.016 : 0.048$	0.967
$HP^{t}_{FDI50} + HP^{t-1}_{FDI50}$	0.052	0.012	$0.012 : 0.093$	$0.019 : 0.084$	$0.019 : 0.076$	4.138

Note: SE= standard errors, CI=confidence intervals

Table 8: Splitting the FDI50 spillovers

	(1)	(2)	(3)	(4)	(5)
$HP_t\|_{I-FDI50}$	0.112^{***} (6.33)	0.147^{***} (7.98)	0.146^{***} (7.96)	0.030^{**} (2.79)	0.041^{***} (3.99)
$HP_{t-1}\|_{I-FDI50}$	0.045^{*} (2.56)	0.081^{***} (4.08	0.083^{***} (4.93)	0.014 (1.38)	0.027^{**} (3.01)
$HP_t\|_{D-FDI50}$	0.238^{***} (9.46)	0.220^{***} (9.14)	0.218^{***} (8.56)	0.059^{***} (4.40)	0.059^{***} (4.38)
$HP_{t-1}\|_{D-FDI50}$	0.234^{***} (9.37)	0.149^{***} (6.47)	0.135^{***} (5.56)	0.012 (0.91)	-0.005 (-0.38)
Year	no	yes	yes	yes	yes
Year $\times$ industry	no	no	yes	no	yes
Year $\times$ country	no	no	no	yes	yes
Obs.	$1,508,277$	$1,508,277$	$1,508,277$	$1,508,277$	$1,508,277$
R-squared	2.2%	5.5%	7.4%	22.6%	24.1%
Joint F-Test 1 p-value	42.4 0.000^{***}	81.3 0.000^{***}	78.86 0.000^{***}	9.498 0.006^{***}	25.60 0.000^{***}
Joint F-Test 2 p-value	151.4 0.000^{***}	105 0.000^{***}	86.25 0.000^{***}	13.11 0.000^{***}	7.486 0.006^{**}

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 9: Splitting the FDI50 spillovers according to size

	(5)
HP_t|I-FDI50_(<71 empl)	−0.000 (−0.003)
HP_{t-1}|I-FDI50_(<71 empl)	−0.012 (−0.19)
HP_t|I-FDI50_(71-181 empl)	0.049 (1.93)
HP_{t-1}|I-FDI50_(71-181 empl)	0.050* (2.02)
HP_t|I-FDI50_(>181 empl)	0.041*** (4.05)
HP_{t-1}|I-FDI50_(>181 empl)	0.026** (2.89)
HP_t|D-FDI50_(<71 empl)	0.212* (2.239)
HP_{t-1}|D-FDI50_(<71 empl)	−0.0648 (−0.623)
HP_t|D-FDI50_(71-181 empl)	0.036 (1.286)
HP_{t-1}|D-FDI50_(71-181 empl)	−0.0303 (−0.956)
HP_t|D-FDI50_(>181 empl)	0.0561*** (4.052)
HP_{t-1}|D-FDI50_(>181 empl)	−0.001 (−0.134)
Observations	1,508,277
R-squared	24.2%
Joint F-Test I-FDI50_(<71 empl) p-value	0.0186 0.891
Joint F-Test D-FDI50_(<71 empl) p-value	1.100 0.294
Joint F-Test I-FDI50_(71-181 empl) p-value	7.988 0.004**
Joint F-Test D-FDI50_(71-181 empl) p-value	0.0221 0.882
Joint F-Test I-FDI50_(>181 empl) p-value	25.64 0.000***
Joint F-Test D-FDI50_(>181 empl) p-value	6.978 0.008**
F-test equal LT-effects I-FDI50 & D-FDI50 (<71 empl) p-value	1.403 0.236
F-test equal LT-effects I-FDI50 & D-FDI50 (71-181 empl) p-value	4.796 0.028*
F-test equal LT-effects I-FDI50 & D-FDI50 (>181 empl) p-value	0.424 0.515

Note: t statistics in parentheses. Joint F-test is a test for no long run effect for the indicated set of foreign firms.
This regression includes year, year-industry, and year-country fixed effects.
One star means significance at 5% level,two stars at 1% level and three stars at 0.1% level.

(Appendix to manuscript by McGaughey, Raimondos, LaCour, *What is a foreign firm? Implications for productivity spillovers.*)

Appendix 1

In this appendix we carefully report the different steps we went through to create the database that we use. We start with the variable list and the sample delimitations.

Table A.1 List of variables used in TFP estimations and regressions and sample delimitations

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 at least 10% direct single foreign ownership and 0 otherwise. Sources: Amadeus Coverage: 2001-2008
FDI50	A dummy equal to 1 if at least 50% ultimate 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
Herfindahl	Calculated as the sum of the squared market shares in a given 2 digit industry, country and year. Sources: Based on OPRE from Amadeus, Orbis. Coverage: 2001-2008
Horizontal presence, HP	Calculated as the share of revenues of foreign firms in a given 3 digit industry, country and year. Sources: Amadeus Coverage: 2001-2008
Ultimate Owner	Extracted directly from BvD as the GUO variable, that in turn relates to whether the firm is independent or not.The ownership path that leads from a foreign affiliate to the identification of the ultimate owner is a chain of majority voting shares, where the first firm in the ownership chain is the direct owner and the last in the chain is the global ultimate owner.

We continue with some details from our preparatory work.

a. PPIs and deflation

As our sample period covers years where different versions of the EUROSTAT producer price indices (PPIs) exist, we make our deflation consistent by using the NACE revision 1 for most of the countries. For Romania where only the NACE revision 2 exists, we use this deflator instead. For operating revenue (OPRE) and material costs (MATE) we use PPI with a base year in 2005. For capital costs (TFAS) we use the capital deflator for 2005. Following Javorcik (2004), the capital deflator is the simple average of the PPIs from five capital-equipment producing industries: machinery and equipment; office, accounting and computing machinery; electrical machinery and apparatus; motor vehicles; trailers and semi-trailers and other transport equipment. As we use number of employees as our measure of labor no deflation is needed for this variable.

b. Economic activity variables

The AMADEUS DVDs are used in the following way: first, we collect as many accounting variables as possible for each of the years 2001 – 2008 from the most recent DVD in our possession (the 2010 DVD). [1]

For our purpose, we need data in their unconsolidated form. This is also basically what AMADEUS offers. However, in some cases – especially for large MNEs' headquarters – the data appear as consolidated. In those cases, we first try to get hold of the true unconsolidated data by combining our AMADEUS data with data from ORBIS.

In case of missing values for our unconsolidated variables, we fill in from previous versions of the DVDs where such values are available (we have DVDs back to 1996). Our procedure runs as follows: in case of missing values for a certain year, we first try to fill in by looking for that specific value on a DVD from a previous year. Table A.2 summarizes our retrieval of activity variables. From the table it is seen that we lose most observations due to (1) countries with missing observations for material costs or PPI (approx. 2.5 mill obs.) and (2) more randomly missing activity values (approx. 4.7 mill obs.). Note: the light grey rows show total numbers of observations at a given stage in the process. The white rows show the changes to the number of observations for the given action.

[1] Due to the updating procedure of AMADEUS the most complete sample is often two years prior to the actual date of a DVD hence we stop our sample in 2008. This coincides with the start of the GFC and thus we avoid the implications that such a global crisis has on firms.

Table A.2 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 non-manufacturing 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
Obs. with zero or negative activity data set to missing	35,814	7,135	510,721	106,521	-
Total after setting observations with zero or negative activity data to missing	4,047,751	3,461,957	3,775,481	3,271,529	-
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	4,680,769
Total after deleting all obs with any missing values	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**

c. Ownership variables

For the ownership variables we need the full set of DVDs to be able to allow ownership to vary over the years. For ownership variables we also face problems of missing values. To save observations we fill in 'forward' based on the assumption that if a company has once been influenced by foreign ownership it will keep some knowledge for the years to come. Hence once a firm has had the value 1 for one of the 'foreign' dummies, the 1 is kept for future years as well. Similarly, if the last observation was a "0", i.e. not a foreign firm, we fill forward by zeros. This reasoning is also consistent with Altomonte and Pennings (2009) who, using a Romanian data set drawn from Amadeus, found that a MNE in 2000 or 2001 had a 15% chance it was a domestic firm the year prior, whereas the possibility of the firm switching from being a MNE to a domestic firm was "negligible" (p. 1148). Tables A.3 summarizes our retrieval of ownership observations. As shown, it is only a relatively small share of the observations that are obtained by the fill-forward procedure.

Table A.3. Retrieving and interpolation of ownership variables

	Tot. obs	Total Filled Forward	"0" Filled Forward	"1" 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

d. Trimming of the data

We trim our data to remove potential outliers by dropping the top and bottom 1% quantiles of the observations in each 2 digit NACE industry, in each country, in each year [2]. We do that based on a combination of growth rates and ratios for the activity variables (we consider growth rates calculated as log changes of OPRE, EMPL, MATE and TFAS and ratios calculated as MATE/OPRE, TFAS/EMPL, OPRE/EMPL). Finally, we drop country-industry combinations with less than 100 observations available for TFP estimation; see Table A.4.

Table A.4: Loss of observations and industry-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

After the TFP estimations, we also drop observations from country-industry combinations with negative coefficients for either labor, capital or material costs. As this procedure implies that we drop different numbers of observations depending on the choice of 'foreign' definition (because this choice affects the construction of the HP measures used in the TFP estimation), we summarize our loss of information due to negative coefficients in the production function in Table A.5.

[2] We do the trimming at these levels as we estimate the total factor productivity for each NACE 2 in each country.

Table A.5: Loss of observations and industry-country combinations due to negative coefficients in production function estimations

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