Productivity Spillover Effects from Foreign Direct Investment and Multinational Firm Heterogeneity

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Abstract

We analyze whether foreign firms' productivity levels determine their potential as a source of productivity spillover effects to domestic firms. Only sufficiently productive foreign firms generate positive backward spillover effects to domestic supplier firms. Foreign firms with a productivity level more than two standard deviations higher than the productivity level of a given domestic firm are the main source of spillover effects for that firm. Domestic firms with higher productivity levels enjoy larger total positive spillover effects. When supplying foreign firms that are less productive than themselves, domestic firms experience zero to negative spillover effects.

Keywords: FDI spillovers, multinationals, firm heterogeneity, technology transfer
JEL classification: F2, O3

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1 Introduction

Many developing and developed countries have implemented investment promotion policies to attract foreign direct investment. Policymakers believe that foreign direct investment (FDI) will contribute to faster economic growth and welfare through increases in capital stocks, improvements in technology, and through the creation of jobs (Harding and Javorcik, 2011; Borensztein et al., 1998). Aside from these direct effects, policymakers also expect substantial indirect positive spillover effects on domestic firms. Through a range of channels, see Crespo and Fontoura (2007), domestic firms may benefit from the presence of foreign firms. Expected benefits are fuelled by the idea that foreign firms must have some special advantages, such as superior technology, in order to enter new markets successfully (Markusen, 1995).

Recent trade literature that incorporates the mode of foreign market access into trade theory supports the latter idea. For horizontal investment Helpman et al. (2004) show that only the most productive firms in an industry engage in foreign activities. Of those firms that serve foreign markets, only the most productive engage in FDI. Antràs and Helpman (2004) obtain a similar finding for vertical investment. If FDI occurs (which is not necessarily the case, depending on model parameters more productive firms might only buy intermediates from independent suppliers abroad), then only the most productive firms invest abroad. In both models, only firms with a sufficiently high productivity level are able to cover the costs associated with foreign investment. Helpman et al. (2004) present empirical evidence for France. For a large sample of Euro-area firms Geishecker et al. (2009) confirm that firms with affiliates abroad are more productive and contribute more to economy-wide productivity growth.

In the empirical literature, there is a consensus on the superiority of foreign relative to domestic firms in the host country in terms of productivity levels (**?**). The latter result typically refers to the average TFP premium for foreign firms. For our Romanian data we obtain a similar result when regressing our productivity measure on a set of industry-year interaction dummies and a foreign ownership dummy.[1] (**?**) confirm a productivity premium for foreign firms through a matching analysis. The analysis of FDI spillover effects, however, builds on interactions between many domestic and foreign firms. Therefore the comparison of all individual domestic and foreign firms is relevant in the analysis of FDI spillover effects. When we plot the distributions of productivity levels of foreign and domestic firms for e.g. the 'Manufacture of food products and beverages' industry (NACE revision 1.1[2], 15) in Figure 1, we observe that although the distribution for foreign firms is clearly to the right, the level

[1] For our TFP measure obtained using the Olley-Pakes estimator (Olley and Pakes, 1996) we get a coefficient of 0.094 with a standard error of 0.003.

[2] Nomenclature générale des Activités économiques dans les Communautés Européennes

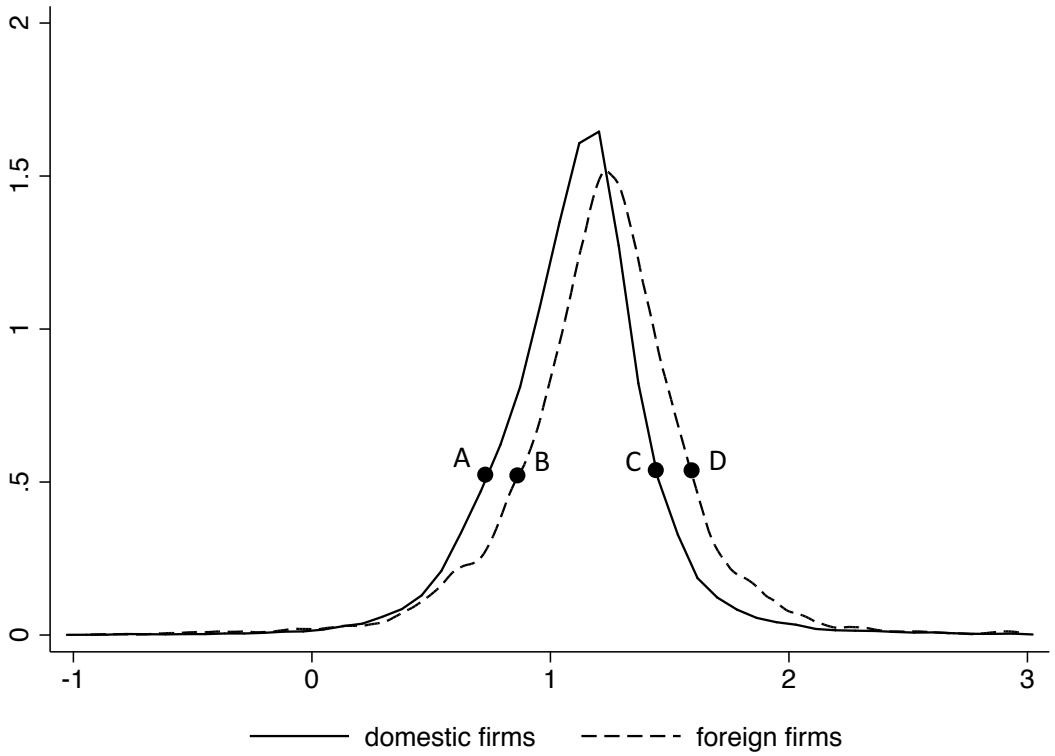

Figure 1: Density plot of Olley-Pakes (OP) TFP for domestic and foreign firms in the 'Manufacture of food products and beverages' industry (NACE 2-digit industry 15, revision 1.1).

of productivity of the most productive domestic firms certainly does not fall short of the level of productivity of many foreign firms. Interpreting a foreign firm's productivity level as a summary measure of its special characteristics, Figure 1 raises the question whether all foreign firms carry an equal potential as source of spillover effects.

Sjöholm (1999) shows the scope for positive spillover effects to increase with the distance to the foreign firm technology frontier. This suggests to expect bigger spillover effects from foreign firms with higher productivity levels. However, although foreign firms with higher productivity levels might offer a larger scope for positive spillovers, domestic firms need to be able to tap into this potential. The latter idea is not new to a literature that has often used the distance between a domestic firm's productivity level and the frontier foreign firm(s) as an indicator of the former's absorptive capability. In this form domestic firm heterogeneity has received a considerable amount of attention (Crespo and Fontoura, 2007).

Kokko (1996), for example, finds that horizontal spillovers are positive and significant only for plants with small or moderate technology gaps relative to foreign firms. Combining scope and absorptive capability arguments leads to potential non-linearities. Girma and Görg (2007) find a U-shaped relationship between productivity growth and their horizontal spillover variable interacted with the level of technology and Girma (2005) observes that horizontal spillovers increase with absorptive capability up to a threshold level, beyond which the increase is much less pronounced. Damijan et al. (2013) find that positive horizontal spillovers are more likely to accrue to high productivity firms with higher absorptive capacities, while negative horizontal spillovers are more likely to affect low productivity firms.

In this paper, we jointly analyse domestic and foreign firm productivity heterogeneity in the FDI spillover framework. Figure 1 further illustrates the setting for our analysis. The Figure shows two domestic firms A and C and two foreign firms B and D singled out. Foreign firm D is among the most productive (foreign) firms in the market, while B is at the lower end of the foreign firms' productivity distribution. On the one hand, only the most productive foreign firms such as D might carry the potential to generate positive spillover effects, but, on the other hand, the gap between D and the domestic firms might be too wide for spillover effects to manifest themselves. Firm B would then be a more likely source of spillovers effects. The absorptive capability of domestic firms will matter as well. Domestic firm C may not benefit from linkages with foreign firm B because C is more productive than B, but C may well benefit from the presence of foreign firm D. Firm A, on the other, hand might benefit from B, but not from D, or it may even lack the absorptive capability to benefit at all.

Some authors have investigated other types of foreign firm heterogeneity. Javorcik and Spatareanu (2008) examine the relationship between a firm's ownership structure (partially versus wholly foreign-owned) and spillover effects. Javorcik and Spatareanu (2011) differentiate between American and European MNEs in order to determine how spillovers are affected by the origin of foreign investors. Work by Marin and Bell (2006) and Marin and Sasidharan (2010) explores how differences in technology-related activities in foreign subsidiaries affect ensuing spillovers, Castellani and Zanfei (2007) look into heterogeneity of foreign affiliates in terms of R&D activities. Nicolini and Resmini (2010) investigate whether spillovers generated by MNEs in low-tech manufacturing sectors are different from those generated by MNEs in high-tech manufacturing sectors. However, to the best of our knowledge, productivity heterogeneity of domestic and foreign firms have not yet been *jointly* analyzed as a determinant factor of FDI spillover effects.

For our analysis, we use a panel of Romanian manufacturing firms. First, we split the

traditional spillover variables into components that refer to foreign firms that have a 'higher' or 'lower' productivity level than the focal domestic firm. We find that linkages with foreign clients with higher productivity levels result in positive backward spillover effects. Linkages with foreign firms of lower productivity, by contrast, result in zero to negative backward spillover effects. We then refine the analysis and investigate how foreign firms' productivity levels interact with a focal domestic firms' productivity level as an indicator of both the scope for spillover effects and the domestic firms' ability to capture them. We find that especially linkages with foreign firms with a productivity level more than two standard deviations larger than the focal domestic firm boost the latter's productivity. Domestic firms with the highest initial productivity levels benefit most from backward spillover effects.

The remainder of the paper is structured as follows. In Section 2, we introduce the standard empirical framework for the analysis of spillover effects from foreign direct investment. This section also presents our data. Section 3 inserts foreign and domestic firm heterogeneity in the standard empirical framework and presents and interprets the results. In Section 4, we perform a number of robustness tests. Finally, Section 5 summarizes our key findings.

2 Spillover measurement, empirical framework and data

2.1 Spillovers from foreign direct investment in the standard empirical framework

The literature on linkages and technology transfer between foreign and domestic firms is extensive. Commonly, these indirect or spillover effects from FDI are included as additional inputs explaining total factor productivity (TFP) in a production function framework. Spillovers are categorized into horizontal (intra-industry) and vertical (inter-industry) effects. Horizontal spillover effects occur between firms in competitive relationships in similar stages of the supply chain. Vertical spillover effects arise between firms in supplier-client relationships. In this case, the literature identifies backward spillover effects that originate from linkages between MNEs and their local suppliers and forward spillover effects that originate from linkages between MNEs and their local clients. Following Caves (1974), the first studies on the indirect effects of FDI focused exclusively on horizontal spillovers. Although the idea of vertical spillovers dates back to McAleese and McDonald (1978) and Lall (1980), these vertical effects did not receive a lot of attention until theoretical work by Rodriguez-Clare (1996) and Markusen and Venables (1999) and empirical work by Javorcik (2004) revived the interest. Since then vertical and especially backward spillovers are regarded as the more likely channel for (positive) productivity spillover effects to emerge. Although literature surveys

by Görg and Greenaway (2004), Crespo and Fontoura (2007), Meyer and Sinani (2009) and Havranek and Irsova (2011, 2013) do suggest that overall empirical evidence on FDI spillovers is ambiguous[3], positive backward spillover effects seem robust throughout the literature. Havranek and Irsova (2011) confirm this by means of a meta-analysis. They conclude that the average backward spillover effect of foreign firms on their suppliers is both statistically and economically significant. Havranek and Irsova (2011) further indicate that the best practice estimate of forward spillovers is insignificant. Given these findings and in line with other recent work such as Damijan et al. (2013), we focus on backward spillovers in this study.[4]

To define variables that capture spillover potential the literature typically draws on work by Caves (1974) and Javorcik (2004). Following Caves (1974) the horizontal or intra-industry spillover variables are commonly calculated as follows:

$$Horizontal_{jt} = \frac{\sum_{i \in j} F_{it} * Y_{it}}{\sum_{i \in j} Y_{it}} \tag{1}$$

where Y_{it} is the output produced by firm i in industry j at time t and F_{it} is the share of foreign participation in firm i at time t. A firm is classified as foreign when there is at least a single foreign investor who owns at least 10% of the shares. $Horizontal_{jt}$ captures the degree of foreign presence in industry j at time t by the share of industry j's output produced by foreign firms.

The backward spillover variable for industry j measures the foreign presence in industries c supplied by industry j at time t and is commonly calculated as follows:

$$Backward_{jt} = \sum_{c} \gamma_{jct} * Horizontal_{ct} \tag{2}$$

$Backward_{jt}$ is a weighted average of $Horizontal$ in the sourcing industries c. The weights are technical coefficients: γ_{jct} represents the share of industry j's total intermediate supply that is supplied to each industry c. The technical coefficients are derived from input-output tables for intermediate consumption.

As indicated above FDI spillover variables are introduced as additional inputs explaining total factor productivity in a production function framework. In this paper, we rely on the

[3]A potential explanation for these results is that MNEs fear technology leakage and therefore do not bring their most advanced technologies with them but only technologies that are just sufficiently advanced to allow them to compete with domestic firms (Glass and Saggi, 1998).

[4]Furthermore, Damijan et al. (2013) indicate that foreign affiliates in Eastern Europe (we consider Romania) are mainly engaged in end-user consumer goods.

standard framework (cf. Havranek and Irsova, 2011) and specify equation (3) as our basic model where we relate the productivity level of firm i in industry j at time t to a set of FDI spillover variables, FDI_j, and a set of control variables, Z_{ij}.

$$TFP_{ijt} = \alpha_i + \psi_1 FDI_{jt-1} + \psi_2 Z_{ijt-1} + \xi_{ijt} \tag{3}$$

The set of control variables includes firm age, an indicator of firm size (measured by real output), a Herfindahl index of industry concentration, import competition and export intensity at the industry-level[5], the share of intermediates in total industry output, services spillovers and an index of demand in downstream industries[6]. Equation (3) is first-differenced and time (α_t), industry (α_j), and region (α_r) dummies are added to obtain equation (4) which is estimated by OLS. Since the estimation is performed at the firm-year level while some of the explanatory variables are defined at the industry-year level, we cluster standard errors at the industry-year level (see Moulton, 1990).

$$\Delta TFP_{ijt} = \psi_1' \Delta FDI_{jt-1} + \psi_2' \Delta Z_{ijt-1} + \alpha_t + \alpha_j + \alpha_r + \epsilon_{ijt} \tag{4}$$

Because the input choices of a firm are likely to be based on its productivity, the estimation of total factor productivity (TFP) will be biased if the endogeneity of inputs is not addressed (Griliches and Mairesse, 1995). A number of alternative estimation procedures have been suggested in order to tackle this issue. The most popular alternatives are the semi-parametric approaches developed by Olley and Pakes (1996) (OP) and Levinsohn and Petrin (2003) (LP). In these semi-parametric approaches, a proxy is introduced to handle the endogeneity bias. Olley and Pakes (1996) use investment as a proxy.[7] Levinsohn and Petrin (2003) argue that investment is lumpy and does not respond smoothly to productivity shocks and propose to use material inputs as a proxy instead. In a more recent contribution, Ackerberg et al. (2008) (ACF) present an alternative semi-parametric procedure that deals with potential collinearity issues in Olley and Pakes (1996) and Levinsohn and Petrin (2003). As the discussion is still

[5]Unfortunately this information is not available at the firm-level.

[6]Downstream foreign entry could increase demand for intermediate products which may result in scale economies. To separate this effect, the regression includes demand for intermediates following Javorcik (2004) calculated as:

$$demand_{jt} = \sum_k a_{jk} * Y_{kt}$$

where α_{jk} is the IO-matrix coefficient which indicates that in order to produce one unit of good k, α_{jk} units of good j are needed. Y_{kt} is the output of industry k deflated by an industry-specific deflator.

[7]We apply the procedure from Amiti and Konings (2007) to compute investment from our data.

ongoing, we present results for OP in the paper and results for ACF TFP in Appendix B.[8] TFP estimates are obtained from production functions estimated for each NACE 2-digit manufacturing industry separately. (4) pools domestic firms from all these manufacturing industries.

2.2 Data

For our empirical analysis, we use a large panel of Romanian firms extracted from the Amadeus database by Bureau Van Dijk Electronic Publishing. The Amadeus database consists of financial and ownership information on public and private companies across Europe (Bureau Van Dijk, 2011). From this large database, we constructed a sample covering the period 1996-2005.[9] Other work that makes use of the Amadeus database has pointed out the excellent coverage of the subset of Romanian firms (see e.g. Altomonte and Colantone (2008), or Merlevede et al. (2014), forthcoming). Foreign direct investment started to enter Romania only in the late 1990s after the implementation of several privatization and market access reforms (UNCTAD, 2003). Combined with an excellent coverage, the timing of the start of FDI inflows makes Romania in 1996-2005 an ideal setting to study FDI spillover effects. FDI was also concentrated in the manufacturing industries in the period covered (Pauwels and Ionita, 2008). Table 1 shows the number of firms as well as entry and exit for all firms and for the sub-sample of foreign firms by year. The 2003 exit rate is high but this pattern is confirmed by data from the Romanian Trade Register. The last column of Table 1 shows the percentage of firms that is foreign. From this column we infer that foreign activity has risen considerably: whereas only 16% of the total number of firms was foreign in 1996, the number had increased to 22% by 2005. Most of these investors are European.

We focus on firms with at least five employees on average and remove the top and bottom percentiles of the annual growth rates of real operating revenues, real material inputs, real capital and labour.[10] Nominal data are deflated with industry price-level data at the NACE 3-digit level. Price-level data are taken from the Statistical Yearbook of the Romanian

[8]Other recent efforts include TFP estimation based on firm-level quantity data (TFPQ) rather than deflated revenue data (TFPR). Unfortunately, data on quantities are not available to us. Results should therefore be interpreted with this caveat in mind.

[9]We use multiple issues (published on DVDs) of the database because a single issue is only a snapshot of the ownership information and firms that exit are dropped from the next issue released. In order to get a full overview of ownership and financials through time, multiple issues are required. See Merlevede et al. (2014), forthcoming.

[10]If the 'outlier' is due to the first or last observation for a specific firm and other data points are normal, the other firm-year data are kept. If this is not the case, all observations for the firm are dropped from the data.

Table 1: Overview of the number of firms, entry, exit and the penetration of foreign firms in the sample.

	All firms			Of which foreign firms			
	#firms	entry	exit	#firms	entry	exit	penetration
1996	14393	-	-	2242	-	-	0.16
1997	15618	1057	91	2615	315	32	0.17
1998	16768	996	190	3005	328	59	0.18
1999	18054	1200	761	3464	373	169	0.19
2000	19480	1845	301	3940	472	72	0.20
2001	20908	1374	507	4458	445	119	0.21
2002	21912	1224	988	4792	332	305	0.22
2003	22579	1336	2447	4896	298	493	0.22
2004	21525	1066	562	4831	314	168	0.22
2005	20963	-	-	4667	-	-	0.22

Statistical Institute (RSO, 2005) and the Industrial Database for Eastern Europe from the Vienna Institute for International Economic Studies (WIIW, 2007). Labour (L) is the number of employees. Real output (Y) is constructed by deflating operating revenues with industry-level producer price indices. Real capital (K) is calculated as tangible fixed assets deflated by the average of the following industry deflators: machinery and equipment (NACE 2-digit 29), office machinery and computing (30), electrical machinery and apparatus (31), motor vehicles, trailers and semi-trailers (34) and other transport equipment (35). Real material inputs are obtained by deflating material inputs with a weighted intermediate input deflator. The weights are taken from input-output tables that were obtained from the Romanian Statistical Office. These input-output tables are provided in a Romanian industry code classification that maps into the NACE 3-digit classification. We have a time-series of input-output tables which allows us to calculate time-varying technical coefficients.

Table 2 displays summary statistics of firm-level variables for all firms and for domestic and foreign firms separately. Foreign firms realize more output, have higher capital stocks and employ more workers. On average, they are also more productive than their local counterparts. The Table also presents summary statistics of the traditional horizontal and backward spillover variables. Foreign firms produce on average 27.5% of industry output (based on 464 industry-year observations). This number varies between 0% and 87.2%.

Table 2: Summary statistics of firm-level data, perido 1996-2005.

	All firms		Domestic firms		Foreign firms	
	mean	sd	mean	sd	mean	sd
employment	85.82	409.92	65.15	263.27	137.79	500.64
log real output	13.52	2.03	13.32	1.95	14.25	2.12
log real capital	12.02	2.35	11.75	2.27	12.96	2.35
log real materials	12.67	2.21	12.67	2.21	13.25	2.53
log TFP OP	1.97	0.94	1.93	0.91	2.09	1.01

3 Foreign and domestic firm heterogeneity

Notwithstanding the fact that foreign firms on average are more productive than their local counterparts, Figure 1 and Table 2, testify of a considerable overlap between both types of firms' productivity distributions. Do all foreign affiliates then carry the same potential as a source of spillover effects? In Appendix A we report an analysis of the role of foreign firms' productivity levels in isolation. Our main conclusion that follows from this analysis is that the most productive foreign firms within each customer industry are a source of positive backward spillover effects. Foreign firms with low to medium productivity levels (relative to the within-industry average) do not generate spillover effects.

In this section we jointly analyse foreign and domestic firms' productivity levels and allow foreign firms' productivity levels relative to domestic firms' productivity levels to bear an impact on spillover effects. To this end, we define and calculate spillover variables by individual domestic firm and classify foreign firms into two categories: i) foreign firms of higher productivity; and ii) foreign firms of lower productivity than the individual domestic firm f. We then define horizontal spillover variables HR^{higher} and HR^{lower} in (5) and (6). In (7) and (8) we define the inter-industry BK^{higher} and BK^{lower} variables for firm f following a similar logic as in (2). Note that it is the productivity level of domestic firm f in industry j that is compared with the productivity levels of foreign firms in sourcing industries c. The spillover variables defined in (5)-(8) for domestic firm f in industry j at time t enter regression (4) as separate variables to test for different spillover effects related to the relative productivities of the focal domestic firm vis-a-vis its foreign clients.

$$HR_{fjt}^{higher} = \frac{\sum_{i \in j} F_{it} * Y_{it}|_{TFP_{fjt} > TFP_{ijt}}}{\sum_{i \in j} Y_{it}} \tag{5}$$

$$HR_{fjt}^{lower} = \frac{\sum_{i \in j} F_{it} * Y_{it}|_{TFP_{fjt} \leq TFP_{ijt}}}{\sum_{i \in j} Y_{it}} \tag{6}$$

$$BK_{fjt}^{higher} = \sum_{c} \gamma_{jct} * \frac{\sum_{i \in c} F_{it} * Y_{it}|_{TFP_{fjt} > TFP_{ict}}}{\sum_{i \in c} Y_{it}} \tag{7}$$

$$BK_{fjt}^{lower} = \sum_{c} \gamma_{jct} * \frac{\sum_{i \in c} F_{it} * Y_{it}|_{TFP_{fjt} \leq TFP_{ict}}}{\sum_{i \in c} Y_{it}} \tag{8}$$

We then allow for more heterogeneity by considering a further decomposition of the spillover variables in (5)-(8). We calculate the standard deviation of the productivity level for the sample of domestic firms and create firm-specific bins of foreign firms of higher and lower productivity. For each individual domestic firm f we obtain four firm-specific cut-off values by adding/subtracting one/two standard deviations to/from its initial productivity level. We then classify foreign firms based on their initial productivity level vis-a-vis the focal domestic firm to obtain six categories or bins: i) foreign firms whose productivity level is up to one standard deviation higher (lower) than the focal domestic firm's productivity level; ii) foreign firms whose productivity level is between one and two standard deviations higher (lower); and iii) foreign firms whose productivity level is more than two standard deviations higher (lower). For each of these six bins we are now able to compute horizontal (9) and backward (10) spillover variables for a given domestic firm f as follows (with B_{ift}^{x} a dummy variable that takes the value one if foreign firm i falls within bin x relative to focal domestic firm f):

$$HR_{fjt}^{binX} = \frac{\sum_{i \in j} B_{ift}^{x} * Y_{it}}{\sum_{i \in j} Y_{it}} \tag{9}$$

$$BK_{fjt}^{binX} = \sum_{c} \gamma_{jct} * \frac{\sum_{i \in c} B_{ift}^{x} * Y_{it}}{\sum_{i \in c} Y_{it}} \tag{10}$$

Table 3 presents summary statistics for the spillover variables split-up according to these definitions. The share in industry output produced by foreign firms of higher productivity is -averaged over domestic firms- about twice the share in industry output of foreign firms of lower productivity. In 2005, foreign firms of higher productivity account for at least 12% and at most 93% of the total number of foreign firms within their industry (this statistic is

Table 3: Summary statistics of the firm-level spillover variables (107,206 observations).

	(1) Horizontal		(2) Backward	
	mean	*stdev.*	*mean*	*stdev.*
lower	0.096	0.10	0.051	0.05
higher	0.188	0.13	0.093	0.06
lower $_{>2sd}$	0.003	0.02	0.003	0.01
lower $_{<2sd}$	0.012	0.04	0.011	0.02
lower $_{<1sd}$	0.080	0.09	0.036	0.03
higher $_{<1sd}$	0.154	0.12	0.066	0.06
higher $_{<2sd}$	0.027	0.05	0.020	0.02
higher $_{>2sd}$	0.007	0.02	0.007	0.01

obtained as the average over all domestic firms within that industry). The smallest shares are found in various sub-industries of the 'Manufacture of food products and beverages' and the 'Manufacture of wood and of products of wood and cork, except furniture' industries. The largest shares are found in the various sub-industries of the 'Manufacture of machinery and equipment n.e.c.', 'Manufacture of office machinery and computers' and 'Manufacture of radio, television and communication equipment and apparatus' industries. Table 3 further shows that foreign firms whose productivity level falls within one standard deviation of a domestic firm's productivity level account for the largest part of foreign firms' share in industry output (on average about 83% of $foreign$ firms' total output within a given industry). Foreign firms more than one standard deviation more productive than the focal domestic firm on average account for about 12% of foreign firms' total output within an industry which is about 3.5% of total industry output. Within this group foreign firms with a productivity level more than two standard deviations higher than that of the focal domestic firm on average account for less than one percent of total industry output, but there is substantial variation across industries.[11]

[11] Averaged over domestic firms within an industry, in 2005 up to 51% (22%) of foreign firms within the industry are foreign firms with a productivity level more than two standard deviations higher (lower) than the focal domestic firm. The average across industries is 10% (5%). Between 1% and 37% (1% and 32%) of foreign firms have a productivity level between one and two standard deviations higher (lower). The average across industries is 19% (12%). Foreign firms with a productivity level up to one standard deviation higher account for between 10% and 41% of foreign firms within an industry (30% averaged over industries), those with a productivity level up to one standard deviation lower account for between 5% and 39% of foreign firms within the industry (24% averaged).

Table 4: Firm-level spillovers from more and less productive MNEs: baseline estimation results.

	(1)	(2)	(3)	(4)
	non-zero diagonal			zero diag.
HR^{higher}	0.091	0.310***	-	0.346***
	[0.126]	[0.102]	-	[0.103]
HR^{lower}	-0.197	-	-0.359***	-0.428***
	[0.157]	-	[0.116]	[0.112]
BK^{higher}	1.062***	1.209***	-	1.517***
	[0.279]	[0.268]	-	[0.333]
BK^{lower}	-1.269***	-	-1.649***	-1.730***
	[0.330]	-	[0.330]	[0.355]
Obs.	96,681	96,681	96,681	96,681
R^2	0.098	0.	0.	0.100

Second step OLS estimates for domestic manufacturing firms with at least five employees in the period 1996-2005. Regressions include time, industry and region dummies; control variables included are downstream demand, industry concentration, firm age, firm size, import competition, export intensity, the share of intermediate supply in total industry output and services spillovers. Standard errors in brackets are clustered at the industry-year level. ***/**/* denotes significance at 1/5/10 percent.

In Table 4 we present results of estimating (4) with the firm-level spillover variables defined in (5)-(8) included as explanatory variables. Column 1 incorporates all four spillover variables in the estimation. We find no evidence of significant horizontal spillover effects. Backward spillover effects are significant and positive if they originate from foreign firms of higher productivity, but negative and significant if they originate from relationships with foreign firms that have a lower productivity than the focal domestic firm. It is noteworthy that, although they are not significant, the coefficients for the horizontal spillover variables follow a similar pattern. Columns 2 and 3 confirm these results when spillovers from more and less productive foreign firms are considered separately. Horizontal spillover effects do become significant in columns 3 and 4. Column 4 shows results for a 'zero-diagonal' definition of the backward spillover variable. As indicated above, in our view, *Backward* serves as a proxy for linkages between MNEs and their local suppliers, which does include within-industry intermediate supply. Therefore, following Lenaerts and Merlevede (2016), we do include within-industry intermediate supply in our standard definition because it refers to supplier-client relationships (the rationale for backward spillover effects). However following Javorcik (2004), inputs supplied or sourced within the same industry are typically excluded from the

backward spillover definition. Column 4 confirms the opposing positive and negative effects from foreign firms of higher and lower productivity. Horizontal spillover effects are significant, but as shown by Lenaerts and Merlevede (2016) they reflect within-industry intermediate supply relationships which we believe to be intuitively part of the backward spillover effect. Our preferred result can thus be found in column 1, but it is not driven by our non-zero definition of the backward spillover variable.

The findings in Table 4 suggest that domestic firms should be careful when entering a supplier contract with a foreign firm. Domestic firms only seem to benefit from linkages with foreign clients of higher productivity.

In Table 5 we allow for more heterogeneity by considering the decomposition of the *higher* and *lower* spillover variables as defined in (9) and (10). Column 1 again includes all spillover variables, whereas columns 2 to 6 test the sensitivity of the results to the exclusion of spillover variables referring to different bins. In line with Table 4 we do not find much evidence for horizontal spillover effects in column 1. Five out of the six backward spillover variables are individually statistically significant however. There is a clear ranking in terms of estimated coefficients with the most productive foreign firms having the largest impact with the impact decreasing with the foreign firm's productivity level (relative to the focal domestic firm). The entry of a foreign firm that accounts for 1% of industry output in a client industry would increase a domestic firm's productivity by 5.7% if it has a productivity level more than 2 standard deviations higher than its domestic supplier. In contrast that same foreign firm would have an impact of 0.6% if its productivity level was less than 1 standard deviation higher and it would have no impact if its productivity level was less than 1 standard deviation lower. Foreign firms of substantially lower productivity than the focal domestic firm have a significant negative impact on the latter's productivity. These results point to the most productive foreign firms as the main source of positive backward spillover effects (cf. Appendix A). Columns 2 to 6 of Table 5 present estimation results in which different subcomponents are considered separately. For backward spillover effects results are in line with the results reported in column 1 with the most productive foreign firms as the most efficient source of spillover effects. As in Table 4 some horizontal spillover effects become significant when not all variables are included in the regression. Foreign firms of higher productivity generally generate positive spillovers, whereas foreign firms of lower productivity generate negative spillover effects.

The definition of e.g. HR^{higher} in (5) implies that -*ceteris paribus*- the '*higher*' spillover variables will have larger values for domestic firms of lower productivity levels. The previous

Table 5: Firm-level spillovers from MNEs - six firm-specific bins of foreign firms of higher and lower productivity

	(1)	(2)	(3)	(4)	(5)	(6)
Horizontal						
higher $_{>2sd}$	0.606	0.828	-	0.160	-	-
	[0.503]	[0.505]	-	[0.478]	-	-
higher $_{<2sd}$	-0.136	0.049	-	-	-0.125	-
	[0.175]	[0.166]	-	-	[0.159]	-
higher $_{<1sd}$	0.109	0.269***	-	-	-	0.254**
	[0.120]	[0.093]	-	-	-	[0.109]
lower $_{<1sd}$	-0.123	-	-0.329***	-	-	-0.182
	[0.143]	-	[0.093]	-	-	[0.137]
lower $_{<2sd}$	-0.266	-	-0.422*	-	-0.338	-
	[0.233]	-	[0.229]	-	[0.212]	-
lower $_{>2sd}$	-0.972*	-	-1.177**	-0.153	-	-
	[0.534]	-	[0.546]	[0.519]	-	-
Backward						
higher $_{>2sd}$	5.754***	6.342***	-	7.574***	-	-
	[1.071]	[1.089]	-	[1.099]	-	-
higher $_{<2sd}$	1.875***	2.079***	-	-	2.277***	-
	[0.359]	[0.363]	-	-	[0.376]	-
higher $_{<1sd}$	0.596**	0.738***	-	-	-	0.369
	[0.253]	[0.236]	-	-	-	[0.260]
lower $_{<1sd}$	-0.278	-	-0.750***	-	-	-0.325
	[0.297]	-	[0.254]	-	-	[0.344]
lower $_{<2sd}$	-1.804***	-	-2.567***	-	-2.385***	-
	[0.494]	-	[0.537]	-	[0.580]	-
lower $_{>2sd}$	-4.053***	-	-4.595***	-5.848***	-	-
	[1.149]	-	[1.175]	[1.113]	-	-
Obs.	96,681	96,681	96,681	96,681	96,681	96,681
R^2	0.131	0.107	0.104	0.110	0.084	0.070

Second step OLS estimates for domestic manufacturing firms with at least five employees in the period 1996-2005. Regressions include time, industry and region dummies; control variables included are downstream demand, industry concentration, firm age, firm size, import competition, export intensity, the share of intermediate supply in total industry output and services spillovers. Standard errors in brackets are clustered at the industry-year level. ***/**/* denotes significance at 1/5/10 percent.

estimations therefore do not satisfactory account for the potential impact of domestic firms' productivity levels as indicator of absorptive capability. The literature, however,

Table 6: Firm-level spillovers from more and less productive MNEs: further decomposition and domestic firm heterogeneity.

	(1)	(2)	(3)	(4)
	Q1	**Q2**	**Q3**	**Q4**
HR more $_{>2sd}$	1.254	0.019	0.14	-0.528
	[0.782]	[0.725]	[0.631]	[0.924]
HR more $_{<2sd}$	0.232	0.247	-0.173	-0.24
	[0.207]	[0.210]	[0.198]	[0.282]
HR more $_{<1sd}$	0.155	0.163	0.209	0.024
	[0.134]	[0.177]	[0.150]	[0.210]
HR less $_{<1sd}$	-0.191	-0.074	-0.045	-0.253
	[0.206]	[0.202]	[0.147]	[0.251]
HR less $_{<2sd}$	-1.187*	-0.984	-0.16	-0.273
	[0.713]	[0.722]	[0.280]	[0.258]
HR less $_{>2sd}$	-7.028***	1.626	-0.222	-0.472
	[2.253]	[2.277]	[1.162]	[0.495]
BK more $_{>2sd}$	2.709**	5.359***	8.385***	12.339***
	[1.099]	[1.505]	[1.917]	[3.450]
BK more $_{<2sd}$	1.069***	1.055**	2.048***	2.643**
	[0.309]	[0.414]	[0.670]	[1.302]
BK more $_{<1sd}$	0.126	-0.103	0.806**	1.056**
	[0.152]	[0.323]	[0.391]	[0.515]
BK less $_{<1sd}$	-0.663*	-0.802**	-0.381	0.941
	[0.386]	[0.362]	[0.360]	[0.627]
BK less $_{<2sd}$	-0.181	-1.051	-1.758***	-0.607
	[1.717]	[1.529]	[0.569]	[0.544]
BK less $_{>2sd}$	5.047	-12.159**	-6.310**	-3.241***
	[4.499]	[5.101]	[2.517]	[0.946]
Obs.	23,625	23,147	23,615	22,585
R^2	0.139	0.114	0.168	0.231

Second step OLS estimates for domestic manufacturing firms with at least five employees in the period 1996-2005. Regressions include time, industry and region dummies; control variables included are downstream demand, industry concentration, firm age, firm size, import competition, export intensity, the share of intermediate supply in total industry output and services spillovers. Standard errors in brackets are clustered at the industry-year level. ***/**/* denotes significance at 1/5/10 percent.

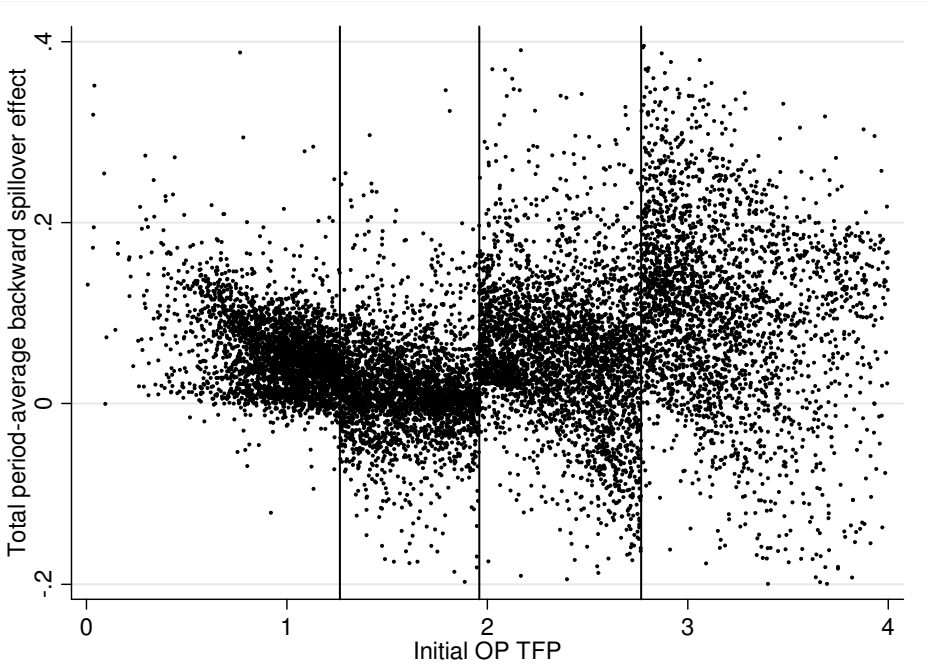

Figure 2: Contribution of the backward spillover to OP TFP by domestic firms' initial poductivity level (total period-average).

has highlighted the importance of absorptive capability of domestic firms as an important determinant of spillover effects (see Crespo and Fontoura, 2007). We introduce absorptive capability in our analysis by assigning domestic firms to different groups according to their initial productivity level. We define four quartiles of initial productivity across all industries and estimate separate regressions for each quartile of domestic firms. The results are presented in Table 6. The overall pattern of backward spillover effects is fairly stable across different productivity quartiles and it is in line with the findings in Table 5. Supplying the most productive foreign firms is again the most efficient channel through which positive spillover effects are transmitted. Domestic firms with lower initial productivity levels (Q1 and Q2 firms with below median initial productivity) seem to benefit only from MNEs in client industries which have a productivity level which is at least one standard deviation higher. Initially more productive domestic firms (Q3 and Q4 firms with above median initial productivity), on the other hand, seem to benefit from all foreign firms that have higher productivity levels. Absorptive capability is at work as domestic firms of higher productivity benefit more from foreign presence. Point estimates for all backward spillover variables are larger for initially more productive domestic firms. Horizontal spillover effects are again largely absent. Only domestic firms with low initial productivity seem to be negatively affected by the presence of foreign firms with very low productivity levels.

Figures 2 shows the total period-average backward spillover contribution to OP TFP in

function of domestic firms' initial level of TFP.[12] Each dot in the graph represents a domestic firm. The vertical lines in the Figure show the cut-off values for the different quartiles. There is considerable heterogeneity across firms, but the majority of domestic firms seems to have benefited from foreign presence in downstream industries. Figure 2 further suggests that a sufficient level of absorptive capacity is required to benefit from positive spillover effects. Overall, positive backward spillover effects are the largest for more productive domestic firms whereas spillovers turn negative for less productive firms. These findings correspond with the results of Gorodnichenko et al. (2014) and Damijan et al. (2013). Gorodnichenko et al. (2014) find positive backward spillovers, but effects decrease as the distance to frontier increases. Damijan et al. (2013) find that domestic firms of lower productivity are more likely to be faced with negative vertical spillover effects. These studies, however, do not address foreign firm heterogeneity.

Could it be that the 'quality' of multinationals entering Romania is driven by their expectation of the productivity evolution in supplier industries? The most productive foreign firms might be attracted to industries where local firms in supplier industries look promising.[13] This is unlikely, we detect foreign presence in all industries and the implication would be that low quality foreign firms are attracted predominantly to industries where expectations regarding the supplying industries are dim. However, since the quality of supplying industries affects the cost of operation in the host country, low quality foreign firms would exactly be attracted to industries where local suppliers look promising. Only very productive foreign firms would be able to enter those industries with low quality suppliers.

While our result that only foreign firms of higher productivity are a source of positive and significant backward spillover effects is intuitive, we also find some significant negative spillover effects from foreign firms of lower productivity. The interpretation of the former result builds on productivity as a manifestation of the scope for technology (in a broad sense) spillover where we find that more able domestic firms learn more from more advanced foreign firms. Whereas zero spillover effects of foreign firms that are less productive than the focal domestic firm might be expected using a similar line of reasoning, significant negative backward spillover effects from foreign firms that are less productive require further understanding. This result could be rationalised through a matching framework. Foreign clients and domestic suppliers are searching partners for an input-output relationship. The domestic

[12] Figures showing only the contribution of statistically significant backward spillover effects are very similar.

[13] This would be observationally equivalent to a situation where foreign firms with higher productivity levels identify industries with more potential for *'actively and successfully assisting and developing local suppliers'* at low cost. If high quality foreign firms are able to predict productivity evolutions in supplier industries, it is also highly likely that they will be able to discern such possibilities as well.

firm's expectation is that the foreign firm will have superior technology and that it will be able to benefit from technology transfer. However, before a contract is signed and operations start, both partners only observe a distorted signal of each other's true productivity level. When domestic firms make relation specific investments in order to supply the foreign firm and true productivity levels are only revealed after operations start, domestic firms may find themselves in a situation where they have signed a contract with a foreign firm of lower productivity to suffer a decrease in measured productivity as a consequence.

Since not all foreign firms are a source of positive productivity spillover effects, policy-makers should take this issue into account in the design and implementation of investment promotion policies, especially when such policies are intended to attract foreign firms to allow domestic firms to benefit from technology spillovers. Investment promotion policies that imply a decrease in the fixed costs of entry for foreign firms, will result in foreign firms of lower productivity entering the host country market. The marginal effect of additional investment promotion is therefore not necessarily associated with positive FDI spillover effects, nor is the existence of a current positive spillover effect a guarantee for additional positive effects. However, in addition to the indirect effects of FDI, there are also direct effects. Although less productive foreign firms may not give rise to positive spillover effects, these firms bring capital and jobs. In our data, capital and employment levels of foreign firms are only poorly correlated with their productivity levels. Therefore direct effects should also be taken into account in policy making since they may counterbalance the lack of or negative indirect spillover effects.

4 Robustness

In this Section, we perform a number of robustness tests. We focus on the robustness of the results in Table 6 where all different layers of foreign and domestic firm heterogeneity have been integrated in the analysis.

In the presence of large productivity differences across industries, the split of domestic firms in four initial productivity quartiles my result in firms from different industries clustering together in specific quartiles. To make sure that our results are not driven by industry-specific patterns, we create initial productivity quartiles for domestic firms *within* each 3-digit industry (rather than for the entire manufacturing sector) and then aggregate firms from different industries in Qx-groups. Each 3-digit industry will thus be represented in each Qx with 25% of domestic firms from that industry. We then rerun the analysis of Table 6.

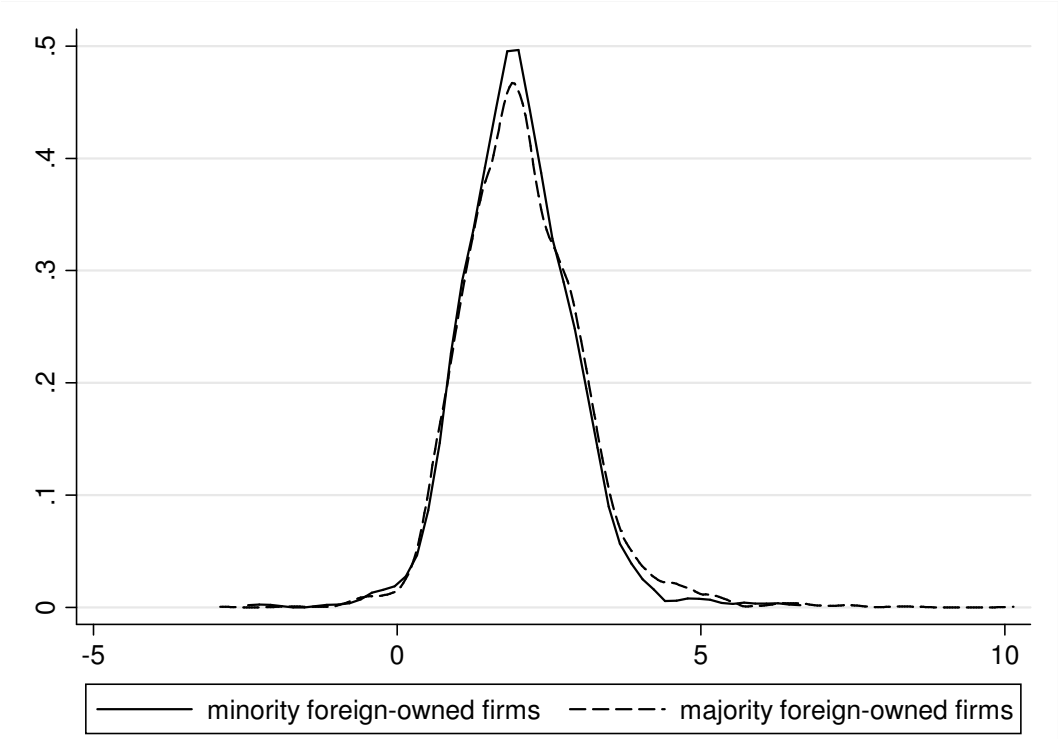

Figure 3: Density plot of OP TFP for minority and majority foreign-owned firms in 2005.

Table 7 shows the results of this approach and qualitatively confirms our earlier findings: the most productive domestic firms benefit most from the most productive foreign firms through backward spillover effects. Compared to Table 6 the differences between low and high productive domestic firms are less pronounced. Low productive domestic firms also seem to experience negative spillover effects from low productive foreign firms *within* their industry.

As a second robustness test, we use a balanced subsample of domestic firms that are present in the sample from 1996 till 2005. The results of this analysis are reported in Table 8. A comparison of Tables 6 and 8 immediately reveals that the empirical results are highly similar for all spillover variables. Positive backward spillovers are mainly driven by foreign firms with a productivity level that is at least one standard deviation higher than the focal domestic firm, with the exception of the most productive Q4 domestic firms that absorb positive backward spillovers from all foreign firms with a higher productivity level. These firms also benefit most from spillover effects. We again detect significant negative backward spillover effects from less productive foreign firms. Our results are therefore not driven by specific entry or exit patterns in the data.

We have shown that productivity heterogeneity among domestic and foreign firms is an

Table 7: Firm-level spillovers from more and less productive MNEs: further decomposition and domestic firm heterogeneity (alternative decomposition of local firms)

	(1)	(2)	(3)	(4)
	Q1	**Q2**	**Q3**	**Q4**
HR more $_{>2sd}$	0.513	0.564	0.68	0.409
	[0.414]	[0.673]	[0.876]	[0.915]
HR more $_{<2sd}$	-0.098	-0.482**	-0.139	0.132
	[0.134]	[0.198]	[0.256]	[0.253]
HR more $_{<1sd}$	-0.043	0.069	0.259*	0.212
	[0.096]	[0.136]	[0.152]	[0.164]
HR less $_{<1sd}$	-0.447***	-0.197	0.136	0.066
	[0.159]	[0.177]	[0.189]	[0.178]
HR less $_{<2sd}$	-1.405***	-0.243	-0.109	0.153
	[0.415]	[0.322]	[0.323]	[0.274]
HR less $_{>2sd}$	-3.310***	-2.227**	-0.066	-0.022
	[1.088]	[1.086]	[1.372]	[0.647]
BK more $_{>2sd}$	4.748***	6.767***	5.595***	8.085***
	[0.820]	[1.659]	[1.743]	[1.845]
BK more $_{<2sd}$	1.219***	2.353***	2.284***	2.032***
	[0.259]	[0.462]	[0.454]	[0.529]
BK more $_{<1sd}$	0.294	0.692***	0.694**	1.000***
	[0.217]	[0.266]	[0.307]	[0.324]
BK less $_{<1sd}$	-0.339	-0.298	-0.575	0.2
	[0.371]	[0.388]	[0.392]	[0.328]
BK less $_{<2sd}$	-1.730**	-2.237***	-2.095***	-1.263**
	[0.670]	[0.718]	[0.728]	[0.549]
BK less $_{>2sd}$	-2.141	-0.251	-6.919***	-4.607***
	[2.238]	[1.962]	[2.502]	[1.451]
Obs.	22,483	23,911	24,003	22,575
R^2	0.128	0.134	0.156	0.141

Second step OLS estimates for domestic manufacturing firms with at least five employees in the period 1996-2005. Regressions include time, industry and region dummies; control variables included are downstream demand, industry concentration, firm age, firm size, import competition, export intensity, the share of intermediate supply in total industry output and services spillovers. Standard errors in brackets are clustered at the industry-year level. ***/**/* denotes significance at 1/5/10 percent.

Table 8: Firm-level spillovers from more and less productive MNEs: further decomposition and domestic firm heterogeneity (balanced panel of local firms).

	(1)	(2)	(3)	(4)
	local Q1	**local Q2**	**local Q3**	**local Q4**
HR more $_{>2sd}$	2.099*	-0.773	-0.421	-0.647
	[1.117]	[0.736]	[0.872]	[0.822]
HR more $_{<2sd}$	0.258	0.029	-0.186	-0.194
	[0.260]	[0.228]	[0.263]	[0.314]
HR more $_{<1sd}$	0.175	0.075	0.317*	-0.191
	[0.172]	[0.161]	[0.177]	[0.220]
HR less $_{<1sd}$	-0.114	-0.003	0.018	0.111
	[0.262]	[0.236]	[0.176]	[0.277]
HR less $_{<2sd}$	-1.201	0.527	0.176	-0.325
	[0.870]	[0.826]	[0.367]	[0.301]
HR less $_{>2sd}$	-8.984**	-2.227	-0.178	-0.62
	[3.790]	[2.594]	[1.949]	[0.552]
BK more $_{>2sd}$	2.937**	5.049***	9.115***	11.653***
	[1.145]	[1.557]	[1.999]	[3.826]
BK more $_{<2sd}$	1.188***	2.188***	2.766***	2.581*
	[0.322]	[0.528]	[0.884]	[1.346]
BK more $_{<1sd}$	0.24	0.364	0.445	1.726***
	[0.181]	[0.321]	[0.539]	[0.579]
BK less $_{<1sd}$	-0.868*	-0.888**	-0.421	-0.386
	[0.473]	[0.395]	[0.458]	[0.637]
BK less $_{<2sd}$	-0.315	-4.918***	-1.936**	-1.492**
	[2.308]	[1.827]	[0.767]	[0.657]
BK less $_{>2sd}$	8.379	-5.625	-5.523	-3.977***
	[6.594]	[6.597]	[4.074]	[1.130]
Obs.	17,532	17,532	17,532	17,532
R^2	0.183	0.142	0.186	0.207

Second step OLS estimates for a balanced panel domestic manufacturing firms with at least five employees in the period 1998-2005. Regressions include time, industry and region dummies; control variables included are downstream demand, industry concentration, firm age, firm size, import competition, export intensity, the share of intermediate supply in total industry output and services spillovers. Standard errors in brackets are clustered at the industry-year level. ***/**/* denotes significance at 1/5/10 percent.

important determinant factor of spillover effects. Heterogeneity implies that not all foreign firms carry an equal spillover potential. Could our result be driven by other types of foreign firm heterogeneity that have been studied in the literature?

Javorcik and Spatareanu (2008) find important differences between spillovers originating from minority and majority foreign-owned firms. Figure 3 plots the productivity distributions for majority- and minority-owned foreign-owned firms in our data. It is clear that the distributions for both types of ownership overlap. Therefore potential selection of minority and majority foreign-owned firms in more and less productive categories is not an alternative explanation for our results. Differences in productivity levels of foreign firms are neither driven by the country of origin. For a similar sample of Romanian firms, Javorcik and Spatareanu (2011) compare spillover effects from European and American affiliates. They find that American FDI is more likely to result in larger backward spillover effects. They show productivity levels of European and American affiliates do not significantly differ and hypothesize that their result reflects a higher share of locally sourced intermediates by American firms. In our data firms from particular countries are also spread fairly evenly over initial productivity quartiles of $foreign$ firms. For firms with a Hungarian owner, for example, we find 197 firms in the first, 128 firms in the second, 144 firms in the third and 101 firms in the fourth quartile. For UK-owned foreign firms, these numbers are 69, 72, 155 and 160 respectively. Although there is some tendency for firms with an owner from a developed country to be better represented in the third and fourth quartiles, its magnitude falls short to make for an alternative interpretation of our results. Furthermore, by itself differences in the country of origin in the absence of any specific underlying mechanism seem a poor explanation for differences in spillover effects. Productivity differences are then likely to emerge as a potential candidate to explain the effects. Finally, other foreign firm characteristics such as human capital and R&D efforts are likely to be correlated with their productivity levels. Unfortunately, we do not have data on these variables to analyse potential underlying mechanisms. However, we prefer to think of productivity as an outcome variable that reflects these characteristics. Productivity levels will also not only reflect R&D efforts but also the efficiency and usability of R&D efforts.

Finally, in Appendix B we present a full analysis using ACF TFP rather than OP TFP. The results on the basis of ACF TFP are qualitatively similar to those of OP TFP.

5 Conclusions

Advanced technology is the rationale and ultimate source for productivity spillover effects from foreign to domestic firms. There is ample evidence that foreign firms are more productive than

domestic firms. This evidence refers to average effects or effects obtained through a matching analysis. The FDI spillover framework, however, is based on the idea of interaction between multiple domestic and foreign firms. This makes entire productivity distributions rather than average effects relevant. We document substantial overlap between the productivity distributions of foreign and domestic firms in a sample of Romanian firms. This raises the question whether all foreign firms carry an equal potential as a source of spillover effects relative to each domestic firm. Therefore we jointly analyse heterogeneity in domestic and foreign firms' productivity levels as a determinant factor of spillover effects in this paper. We proceed in stages and first introduce and calculate spillover variables by individual domestic firm, classifying foreign firms in two categories: i) foreign firms of higher productivity; and ii) foreign firms of lower productivity than the focal domestic firm. We then allow for more heterogeneity by considering a further decomposition of these spillover variables. We use the standard deviation of the productivity level of domestic firms to create six types of spillover variables: variables refering to i) foreign firms whose productivity level is up to one standard deviation higher (lower) than the focal domestic firms productivity level; ii) foreign firms whose productivity level is between one and two standard deviations higher (lower); and iii) foreign firms whose productivity level is more than two standard deviations higher (lower). Finally, we introduce the notion of absorptive capability and assign domestic firms to quartiles according to their initial productivity levels and estimate separate regressions for each quartile.

For our empirical analysis, we use a sample of Romanian manufacturing firms during the period 1996-2005. In line with the literature we find that predominantly backward spillover effects are the main channel through which spillover effects from foreign to domestic firms manifest themselves. Only sufficiently productive foreign firms generate positive backward spillover effects to domestic supplier firms. In particular the most productive foreign firms within each industry are the most important source of positive spillover effects. Foreign firms with a productivity level more than two standard deviations higher than the productivity level of a focal domestic firm are the main source of spillover effects for that firm. Domestic firms with higher initial productivity levels enjoy larger total positive spillover effects. When supplying foreign firms that are less productive than themselves, domestic firms experience zero to negative spillover effects.

Because not all foreign firms are a source of positive productivity spillover effects, policy-makers need to take this issue into account in the design and implementation of investment promotion policies, especially when such policies are intended to attract foreign firms to allow domestic firms to benefit from technology spillovers. Investment promotion policies that imply a decrease in the fixed costs of entry for foreign firms, will result in foreign firms

of lower productivity entering the host country. The marginal effect of additional investment promotion is therefore not necessarily associated with overall positive FDI spillover effects. Foreign firms that do not give rise to positive spillover effects do bring capital and jobs. We find capital and employment levels of foreign firms to be poorly correlated with productivity levels. Therefore direct effects need to be taken into account in policy making since they may counterbalance the lack of or negative indirect spillover effects associated with foreign firms of low productivity.

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Appendix

A Foreign firm heterogeneity isolated

In this Appendix we analyse whether the foreign firm's productivity level is important for its capacity to generate spillover effects to domestic firms without taking the latter's productivity level into account. We study the impact of foreign firm productivity heterogeneity on FDI spillover effects by means of a decomposition of the spillover variables defined in (1) and (2) in the main text. First, a foreign firm is assigned to an 'initial' productivity quartile (i.e. the average productivity over the first three years we observe the firm).[14] Then we define four dummy variables, Qx^{TFP} that indicate to which productivity quartile x a foreign firm belongs. For example, $Q1^{\text{TFP}}$ is set to one if the firm belongs to the first (lowest) quartile of the productivity distribution and zero otherwise. As shown in equation (11), we introduce these dummies in (1) to obtain four subcomponents that sum to the original horizontal spillover variable. Using (2) and (11), the backward spillover variable is decomposed accordingly as shown in equation (12). We can now test the implicit assumption that -notwithstanding substantial productivity differences- all foreign firms are an equal source of productivity spillover effects. We do so by entering all HR_{jt}^{Qx} and BK_{jt}^{Qx} as a separate explanatory variables in (3) .

$$
\begin{aligned}
Horizontal_{jt} &= \frac{\sum_{i \in j} F_{it} * Y_{it}}{\sum_{i \in j} Y_{it}} \\
&= \frac{\sum_{i \in j} (Q1^{TFP} + Q2^{TFP} + Q3^{TFP} + Q4^{TFP}) * F_{it} * Y_{it}}{\sum_{i \in j} Y_{it}} \\
&= \frac{\sum_{i \in j} Q1^{TFP} * F_{it} * Y_{it}}{\sum_{i \in j} Y_{it}} + ... + \frac{\sum_{i \in j} Q4^{TFP} * F_{it} * Y_{it}}{\sum_{i \in j} Y_{it}} \\
&= HR_{jt}^{Q1} + HR_{jt}^{Q2} + HR_{jt}^{Q3} + HR_{jt}^{Q4}
\end{aligned}
\tag{11}
$$

[14] The use of average or yearly -time-varying- productivity levels does not qualitatively affect results. These results are available on request.

Table 9: Cross-tabulation of within-industry and across-industry productivity quartiles.

			across industries			
			Q1	Q2	Q3	Q4
within	industries	Q1	10.8	7.5	5.8	1.3
		Q2	7.6	5.8	8.1	3.7
		Q3	5.4	5.7	6.0	8.2
		Q4	0.8	6.2	5.5	11.5

$$
\begin{aligned}
Backward_{jt} &= \sum_c \gamma_{jct} * Horizontal_{ct} \\
&= \sum_c \gamma_{jct} \left(HR_{ct}^{Q1} + HR_{ct}^{Q2} + HR_{ct}^{Q3} + HR_{ct}^{Q4}\right) \\
&= \sum_c \gamma_{jct}\, HR_{ct}^{Q1} + \sum_c \gamma_{jct}\, HR_{ct}^{Q2} + \sum_c \gamma_{jct}\, HR_{ct}^{Q3} + \sum_c \gamma_{jct}\, HR_{ct}^{Q4} \\
&= BK_{jt}^{Q1} + BK_{jt}^{Q2} + BK_{jt}^{Q3} + BK_{jt}^{Q4}
\end{aligned}
\tag{12}
$$

With respect to the classification of foreign firms in initial productivity quartiles we consider three alternatives. First, we determine percentile cut-offs on the basis of the *within*-industry distribution of initial productivity of foreign firms. In this case potential differences in average productivity levels across industries are ignored. The focus is thus on the identification of the best foreign firms within each industry. Second, we use percentile cut-offs that are based on the distribution of initial productivity across all industries. Foreign firms from a specific high or low productivity industry may then cluster in the same quartile (and therefore spillover variable). Intuitively this difference will be especially relevant for the backward spillover effects and boils down to the question whether domestic firms are affected differently by the most productive foreign firms within each downstream industry or whether domestic firms are affected by the most productive foreign firms across downstream industries irrespective of whether the latter belong to the same or different industries. Clearly, both approaches are different only to the extent that the variation within industries is small relative to the variation across industries. Table 9 shows a cross-tabulation of both sets of productivity quartiles with Table entries expressed as a percentage of the total number of foreign firms. The diagonal elements account for about 34% of the observations, so two thirds of foreign firms are classified in a different quartile depending on whether one uses the within- or across-industry distribution of initial productivity. Finally, in the estimations we also

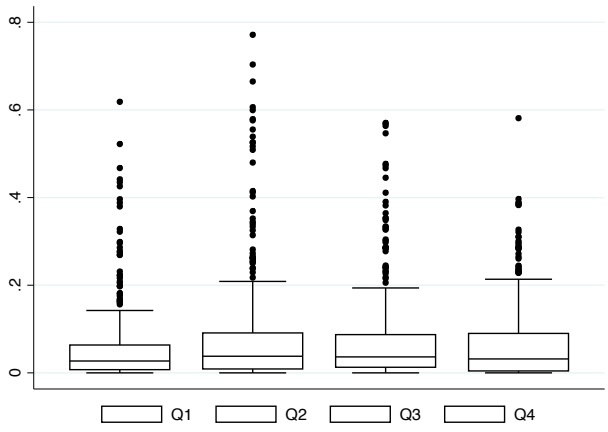

Figure 4: Decomposition of the horizontal spillover variable based on the within-industry distribution of initial productivity (data at the industry-year level)

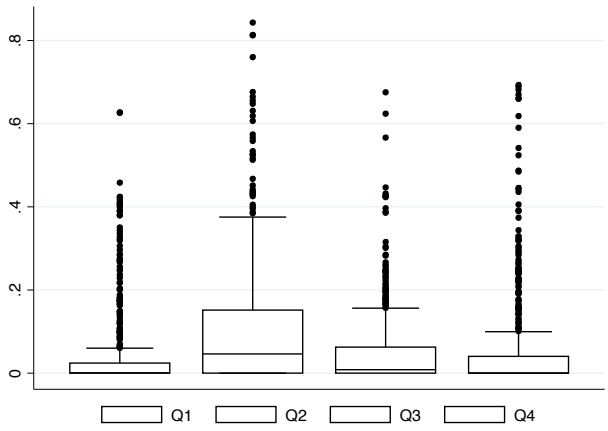

Figure 5: Decomposition of the horizontal spillover variable based on the across-industry distribution of initial productivit (data at the industry-year level)

consider a combination of the previous approaches and split the horizontal spillover variable on the basis of the within-industry distribution of initial productivity and the backward spillover variable on the basis of the distribution across all industries. Figure 4 shows a boxplot of the decomposition of the horizontal spillover variable in four quartiles defined according to the initial productivity level within each industry of foreign firms. The 25% least productive foreign firms seem to produce a somewhat smaller share than the foreign firms in the other quartiles which do not seem to differ systematically in terms of their share in industry output. Figure 5 presents a similar boxplot but now of the decomposition that uses initial productivity levels across manufacturing industries. In this case foreign firms in the second quartile seem more likely to produce larger shares of industry output.

Tables 10 and 11 present results of the estimation of (4) with FDI spillover variables as defined in (11) and (12). Columns 1 to 3 in Table 10 report results for the three alternative decompositions described above, based on OP TFP. Horizontal spillover effects are largely absent in columns 1 to 3. Point estimates suggest that the impact of the most productive foreign firms is the smallest or even negative. Generally, backward spillover effects from the most productive foreign firms are positive and significant. In column 1, which uses the decomposition based on the within-industry distribution of OP TFP, there is a clear ranking in terms of point estimates with the least productive foreign firms within each industry showing the most negative, though not significant, impact on domestic firms' TFP. Only linkages with the most productive foreign firms in each industry result in significant positive spillover effects. Switching to the classification across industries for the backward spillover variable decomposition in columns 2 and 3, foreign firms in quartiles two to four now all contribute positively to domestic firms' TFP. Coefficients are jointly different from zero and cannot be rejected to be equal. In columns 2 and 3 the most productive firms in industries with lower average productive are assigned to quartile two or three (e.g. a quarter of the most productive foreign firms (Q4) within their industry are classified in Q2 across industries (cf. Table 9)). Therefore, combining the results in columns 1 to 3 suggest that especially the most productive foreign firms *within* each industry positively affect domestic firms' TFP.

In column 4 we show results for spillover variables that are calculated using a zero-diagonal definition (*cf. supra*). As argued in **?**, the difference with the previous columns amounts to a 'mechanical' interpretation based on within- and between-industry effects versus more intuitive supply chain, within-industry competition, and labour market effects. The point estimate of the backward spillover effects is now larger, but the change in definition results in smaller values of the backward spillover variables which implies that the total backward spillover effect actually decreases. Horizontal spillover effects from above median productive foreign firms (Q3 and Q4) are now significantly positive. This is in line with **?** who find that the impact of within-industry intermediate supply is likely to be captured as a positive horizontal spillover effects when it is not accounted for in the backward spillover variable due to the use of a zero-diagonal definition. The positive horizontal spillover effect from more productive foreign firms found in column 4 is due to within-industry intermediate supply (hence the smaller size of the backward spillover effect). In columns 5 and 6 of Table 10 we present results on the basis of the estimation of a single production function for the entire manufacturing industry rather than by NACE 2-digit industry. Results confirm the findings for the backward spillover in columns 1 and 3. Finally, Table 11 estimates subcomponents' effects in separate regressions. Table 11 confirms our findings: positive backward spillover

effects primarily arise from the most productive foreign firms.[15]

[15]Combining the 'traditional' non-decomposed horizontal spillover variable, as defined in (1), with decomposed backward spillovers confirms our findings for the decomposed backward spillover effects.

Table 10: Industry-level spillovers from four quartiles of MNEs: baseline estimation results.

	(1)	(2)	(3)	(4)	(5)	(6)
	OP TFP				OP TFP manuf.	
	non-zero diagonal			zero diag.	non-zero diagonal	
	HR within BK within	HR across BK across	HR within BK across	HR within BK across	HR within BK within	HR within BK across
HR Q1	0.869	0.375	0.364	0.406	0.387	0.569*
	[0.641]	[0.389]	[0.429]	[0.423]	[0.438]	[0.307]
HR Q2	0.448	0.159	-0.097	0.181	0.247	-0.102
	[0.471]	[0.241]	[0.414]	[0.383]	[0.400]	[0.283]
HR Q3	0.452	0.112	0.262	0.471**	0.345	0.659
	[0.300]	[0.446]	[0.304]	[0.228]	[0.227]	[0.448]
HR Q4	-0.182	-0.098	0.093	0.403**	0.019	-0.127
	[0.202]	[0.412]	[0.186]	[0.187]	[0.282]	[0.346]
BK Q1	-1.977	-0.365	-0.215	-1.154	-2.216	-1.156
	[2.382]	[0.593]	[0.509]	[1.098]	[1.456]	[0.767]
BK Q2	-1.633	1.067*	1.105**	1.291**	-0.225	2.004**
	[1.159]	[0.565]	[0.467]	[0.629]	[0.835]	[0.850]
BK Q3	-0.337	2.237	2.093	5.373***	-0.343	1.617
	[0.623]	[2.062]	[1.769]	[1.837]	[0.720]	[1.401]
BK Q4	2.416***	1.574**	1.502**	2.760*	2.841***	3.501**
	[0.703]	[0.696]	[0.755]	[1.411]	[0.933]	[1.709]
Obs.	96,681	96,681	96,681	96,681	96.732	96.732
R^2	0.071	0.069	0.069	0.072	0.071	0.072

Second step OLS estimates for domestic manufacturing firms with at least five employees in the period 1996-2005. Regressions include time, industry and region dummies; control variables included are downstream demand, industry concentration, firm age, firm size, import competition, export intensity, the share of intermediate supply in total industry output and services spillovers. Standard errors in brackets are clustered at the industry-year level. ***/**/* denotes significance at 1/5/10 percent.

Table 11: Industry-level spillovers from four quartiles of MNEs: results for each quartile separately.

	(1)	(2)	(3)	(4)	(5)	(6)
	OP TFP				OP TFP manuf.	
	non-zero diagonal			zero diag.	non-zero diagonal	
	HR within BK within	HR across BK across	HR within BK across	HR within BK across	HR within BK within	HR within BK across
HR Q1	0.272	0.280	0.442	0.434	0.203	0.175
	[0.597]	[0.434]	[0.467]	[0.467]	[0.468]	[0.377]
BK Q1	0.931	-0.316	-0.063	-0.932	-0.774	-0.953
	[2.066]	[0.584]	[0.438]	[1.124]	[1.353]	[0.837]
Obs.	96,681	96,681	96,681	96,681	96,732	96,732
R^2	0.061	0.060	0.061	0.061	0.061	0.062
HR Q2	0.531	0.114	0.127	0.161	0.055	0.070
	[0.510]	[0.231]	[0.388]	[0.398]	[0.417]	[0.375]
BK Q2	-1.462	1.091*	1.199***	1.305**	-0.428	1.588***
	[1.279]	[0.561]	[0.461]	[0.594]	[0.922]	[0.595]
Obs.	96,681	96,681	96,681	96,681	96,732	96,732
R^2	0.061	0.064	0.064	0.062	0.061	0.066
HR Q3	0.142	0.091	0.161	0.338	0.081	0.204
	[0.358]	[0.436]	[0.276]	[0.253]	[0.209]	[0.215]
BK Q3	0.542	2.800	2.836*	5.580***	1.320**	1.456*
	[0.638]	[1.933]	[1.642]	[1.703]	[0.656]	[0.801]
Obs.	96,681	96,681	96,681	96,681	96,732	96,732
R^2	0.061	0.063	0.063	0.066	0.063	0.063
HR Q4	-0.165	-0.251	0.282	0.371*	-0.002	0.487**
	[0.204]	[0.416]	[0.203]	[0.207]	[0.283]	[0.242]
BK Q4	2.128***	2.031**	1.540*	4.150***	2.441***	2.380*
	[0.594]	[0.794]	[0.813]	[1.377]	[0.841]	[1.375]
Obs.	96,681	96,681	96,681	96,681	96,732	96,732
R^2	0.069	0.063	0.064	0.064	0.069	0.066

Second step OLS estimates for domestic manufacturing firms with at least five employees in the period 1996-2005. Regressions include time, industry and region dummies; control variables included are downstream demand, industry concentration, firm age, firm size, import competition, export intensity, the share of intermediate supply in total industry output and services spillovers. Standard errors in brackets are clustered at the industry-year level. ***/**/* denotes significance at 1/5/10 percent.

Table 12: ACF TFP Summary statistics of firm-level data, period 1996-2005.

	All firms		Domestic firms		Foreign firms	
	mean	sd	mean	sd	mean	sd
log TFP ACF	5.74	1.52	5.69	1.52	5.95	1.47

B ACF TFP analysis

In this Appendix we repeat the analysis of section 3 and part of section 4 but replace OP TFP with ACF TFP. Tables 13 to **??** present results, Table 12 presents the firm-level summary statistics for ACF TFP. As for OP TFP, foreign firms are on average substantially more productive, but taking into account standard deviations there is a considerable overlap between both distributions.

Table 13 shows that foreign firms with higher productivity levels in downstream activities are the only source of significant positive spillover effects. This confirms our earlier findings for OP TFP in Table 13. In contrast to the OP TFP results, in columns 2 and 3 the coefficients on the horizontal spillover variables are not significant for ACF TFP. Column 4 reveals a similar impact of excluding within-industry intermediate supply from the definition of the backward spillover variables.

In Table 14 we consider the decomposition of spillover variables using the standard deviation of domestic firms' ACF TFP. Columns 1 presents results for the full set of spillover variables, while columns 2 to 6 only use selected subsets of spillover variables. We find that only foreign firms with a productivity level more than 2 standard deviations higher generate significant positive backward spillover effects. Coefficient estimates switch signs between spillover effects from foreign firms with higher and lower productivity levels. Linkages with less productive foreign firms are always significantly associated with negative spillover effects. Point estimates seem inversely related to foreign firm productivity with the most productive MNEs having the biggest impact. Horizontal spillover effects are largely absent. These results again confirm that the most productive foreign firms are the main source of positive backward spillover effects. Allowing for domestic firm heterogeneity through separate estimations for different quartiles of domestic firms' initial productivity level in Table 15 reveals a qualitatively similar pattern of spillover effects as for OP TFP. Quantitatively, domestic firms with higher initial productivity levels do seem to benefit more from foreign presence as point estimates are larger. Domestic firms of low initial productivity now also seem affected negatively by foreign clients with productivity levels less than two standard deviations higher. Figure 6 plots the total period-average backward spillover contribution to

Table 13: Firm-level spillovers from more and less productive MNEs: baseline estimation results for ACF TFP

	(1)	(2)	(3)	(4)
	non-zero diagonal			zero diag.
HR more	0.040	0.223	-	0.578**
	[0.363]	[0.346]	-	[0.229]
HR less	-0.263	-	-0.510	-1.194***
	[0.457]	-	[0.426]	[0.275]
BK more	2.453***	2.746***	-	3.058***
	[0.752]	[0.754]	-	[0.888]
BK less	-5.245***	-	-5.594***	-7.214***
	[1.041]	-	[1.012]	[1.259]
Obs.	73,255	73,255	73,255	73,255
R^2	0.109	0.089	0.097	0.111

Second step OLS estimates for domestic manufacturing firms with at least five employees in the period 1996-2005. Regressions include time, industry and region dummies; control variables included are downstream demand, industry concentration, firm age, firm size, import competition, export intensity, the share of intermediate supply in total industry output and services spillovers. Standard errors in brackets are clustered at the industry-year level. ***/**/* denotes significance at 1/5/10 percent.

domestic firms' ACF TFP as a function of these firms' initial level of TFP. In contrast with OP TFP (*cf.* Figure 2 above), the overall backward spillover effect is zero to negative for a substantial number of firms in this case. In Figure 7 we consider ten deciles of initial levels of domestic firm productivity rather than four quartiles. Figure 7 confirms the general pattern of initially more productive foreign firms benefitting more. Further Figure 7 shows that specifically domestic firms that fall in the lowest decile of initial productivity are negatively affected by foreign presence in downstream industries. A larger number of domestic firms now also seems to enjoy positive spillover effects compared to Figure 6. Defining quartiles of domestic firms' initial productivity level within rather than across industries in Table 16 does not substantially affect results. When we focus on a balanced panel in Table 17 we confirm the general pattern found in the other tables, implying that specific exit and entry patterns are not the driving force for our results.

Table 14: ACF Firm-level spillovers from MNEs - six categories of more and less productive MNEs

	(1)	(2)	(3)	(4)	(5)	(6)
HR more $_{2sd}$	0.453	0.555	-	0.337	-	-
	[0.720]	[0.723]	-	[0.626]	-	-
HR more $_{2sd}$	0.253	0.485	-		0.371	-
	[0.380]	[0.371]	-	-	[0.312]	-
HR more $_{1sd}$	-0.387	-0.116	-	-	-	-0.471*
	[0.322]	[0.301]	-			[0.245]
HR less $_{<1sd}$	-0.543	-	-0.392	-	-	-0.737*
	[0.415]	-	[0.380]	-	-	[0.396]
HR less $_{<2sd}$	-0.290	-	-0.297	-	0.275	-
	[0.794]	-	[0.826]	-	[0.771]	-
HR less $_{>2sd}$	-5.130**	-	-5.248**	-3.946*	-	-
	[2.202]	-	[2.240]	[2.118]	-	-
BK more $_{>2sd}$	7.638***	8.164***	-	8.677***	-	-
	[1.406]	[1.423]	-	[1.313]	-	-
BK more $_{<2sd}$	0.359	0.909	-	-	1.071	-
	[0.884]	[0.886]	-	-	[0.904]	-
BK more $_{<1sd}$	0.343	-0.228	-	-	-	-1.086
	[0.688]	[0.730]	-	-	-	[0.662]
BK less $_{<1sd}$	-2.341**	-	-5.399***	-	-	-5.470***
	[1.022]	-	[1.052]	-	-	[1.147]
BK less $_{<2sd}$	-5.635***	-	-5.564***	-	-13.138***	-
	[1.786]	-	[1.861]	-	[1.981]	-
BK less $_{>2sd}$	-6.570*	-	-8.014**	-16.694***	-	-
	[3.840]	-	[4.038]	[3.650]	-	-
Obs.	73,255	73,255	73,255	73,255	73,255	73,255
R^2	0.147	0.133	0.099	0.136	0.087	0.094

Second step OLS estimates for domestic manufacturing firms with at least five employees in the period 1996-2005. Regressions include time, industry and region dummies; control variables included are downstream demand, industry concentration, firm age, firm size, import competition, export intensity, the share of intermediate supply in total industry output and services spillovers. Standard errors in brackets are clustered at the industry-year level. ***/**/* denotes significance at 1/5/10 percent.

Table 15: ACF Firm-level spillovers from more and less productive MNEs: further decomposition and domestic firm heterogeneity.

	(1) **Q1**	(2) **Q2**	(3) **Q3**	(4) **Q4**
HR more $_{>2sd}$	0.64	0.775	0.874	-1.046
	[0.695]	[0.852]	[0.879]	[1.042]
HR more $_{<2sd}$	0.479*	0.616	0.4	0.073
	[0.276]	[0.506]	[0.505]	[0.650]
HR more $_{<1sd}$	-0.632	0.024	0.288	-0.120
	[0.399]	[0.369]	[0.417]	[0.373]
HR less $_{<1sd}$	-0.204	-0.581	0.035	-0.287
	[0.838]	[0.542]	[0.532]	[0.420]
HR less $_{<2sd}$	1.313	1.006	-0.729	-0.446
	[1.428]	[1.260]	[1.050]	[0.755]
HR less $_{>2sd}$	-11.014*	-2.956	-4.097*	-2.423*
	[6.360]	[2.524]	[2.384]	[1.448]
BK more $_{>2sd}$	6.315***	8.019***	9.729***	15.784***
	[1.431]	[2.092]	[2.562]	[3.279]
BK more $_{<2sd}$	-2.064***	-0.104	2.172	5.379**
	[0.713]	[1.187]	[1.365]	[2.221]
BK more $_{<1sd}$	-0.826	-1.215	0.255	3.637***
	[0.919]	[0.976]	[1.077]	[1.187]
BK less $_{<1sd}$	-5.854***	-1.744	-1.896	0.158
	[2.008]	[1.431]	[1.471]	[1.396]
BK less $_{<2sd}$	-11.267***	-10.299***	-4.235*	-1.997
	[3.660]	[2.882]	[2.416]	[1.866]
BK less $_{>2sd}$	-13.34	-12.282	-21.955***	-6.828**
	[20.832]	[9.366]	[8.168]	[2.792]
Obs.	13,226	16,128	17,457	16,885
R^2	0.168	0.12	0.154	0.254

Second step OLS estimates for domestic manufacturing firms with at least five employees in the period 1996-2005. Regressions include time, industry and region dummies; control variables included are downstream demand, industry concentration, firm age, firm size, import competition, export intensity, the share of intermediate supply in total industry output and services spillovers. Standard errors in brackets are clustered at the industry-year level. ***/**/* denotes significance at 1/5/10 percent.

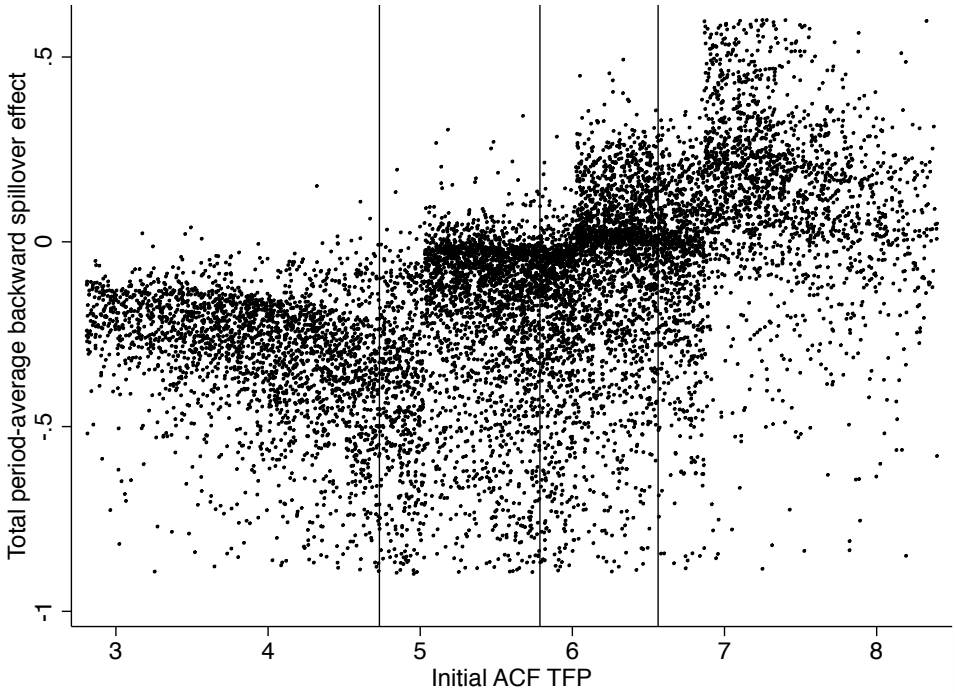

Figure 6: Contribution of the backward spillover to ACF TFP by domestic firms' initial poductivity level (total period-average).

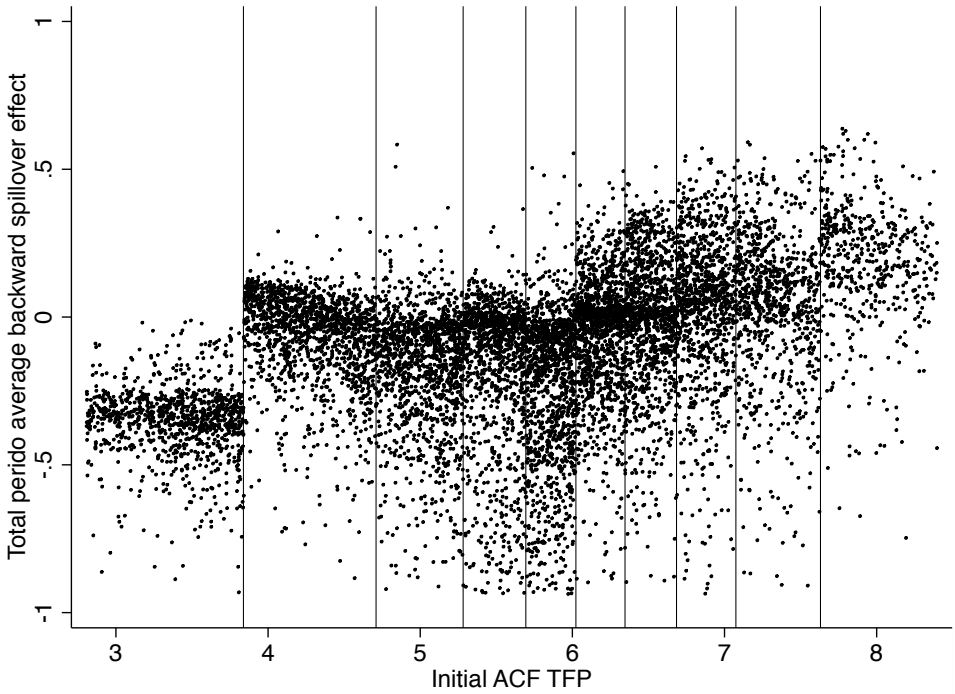

Figure 7: Contribution of the backward spillover to ACF TFP by domestic firms' initial poductivity level (ten deciles of domestic firms, total period-average).

Table 16: ACF Firm-level spillovers from more and less productive MNEs: further decomposition and domestic firm heterogeneity (alternative decomposition of local firms)

	(1)	(2)	(3)	(4)
	Q1	**Q2**	**Q3**	**Q4**
HR more $_{>2sd}$	0.157	0.06	0.66	-0.121
	[0.611]	[0.818]	[0.957]	[1.121]
HR more $_{<2sd}$	0.02	0.233	0.248	0.554
	[0.377]	[0.488]	[0.517]	[0.558]
HR more $_{<1sd}$	-0.936**	-0.239	-0.205	0.172
	[0.380]	[0.360]	[0.428]	[0.459]
HR less $_{<1sd}$	-0.756	-0.571	-0.197	-0.179
	[0.851]	[0.539]	[0.473]	[0.456]
HR less $_{<2sd}$	-1.445	-0.805	0.266	0.022
	[1.373]	[1.016]	[1.029]	[0.722]
HR less $_{>2sd}$	-11.549**	-4.976**	-12.306***	-2.371
	[5.690]	[2.527]	[4.636]	[1.474]
BK more $_{>2sd}$	7.473***	8.995***	8.818***	11.394***
	[1.281]	[1.806]	[2.175]	[2.652]
BK more $_{<2sd}$	-1.161	1.074	1.786	1.113
	[0.901]	[1.270]	[1.372]	[1.410]
BK more $_{<1sd}$	0.035	-0.093	0.813	1.371
	[0.900]	[0.930]	[1.034]	[1.162]
BK less $_{<1sd}$	-4.460**	-1.551	-1.772	-1.641
	[1.986]	[1.475]	[1.287]	[1.162]
BK less $_{<2sd}$	-4.756	-8.380***	-8.383***	-3.613**
	[3.677]	[2.759]	[2.796]	[1.672]
BK less $_{>2sd}$	-23.373	-4.427	-5.282	-6.812*
	[17.061]	[5.914]	[5.143]	[3.878]
Obs.	13,865	16,879	17,172	15,780
R^2	0.153	0.147	0.162	0.164

Second step OLS estimates for domestic manufacturing firms with at least five employees in the period 1996-2005. Regressions include time, industry and region dummies; control variables included are downstream demand, industry concentration, firm age, firm size, import competition, export intensity, the share of intermediate supply in total industry output and services spillovers. Standard errors in brackets are clustered at the industry-year level. ***/**/* denotes significance at 1/5/10 percent.

Table 17: ACF Firm-level spillovers from more and less productive MNEs: further decomposition and domestic firm heterogeneity (balanced panel of local firms).

	(1)	(2)	(3)	(4)
	Q1	**Q2**	**Q3**	**Q4**
HR more $_{>2sd}$	0.414	0.837	0.102	-0.789
	[0.675]	[1.006]	[0.838]	[0.863]
HR more $_{<2sd}$	-0.656	-0.036	0.241	0.208
	[0.434]	[0.694]	[0.657]	[0.438]
HR more $_{<1sd}$	-1.167*	-0.553	-0.09	-0.211
	[0.626]	[0.554]	[0.430]	[0.332]
HR less $_{<1sd}$	-0.45	-0.474	-0.471	-0.489
	[0.891]	[0.921]	[0.625]	[0.349]
HR less $_{<2sd}$	1.588	4.423	-0.394	0.477
	[3.160]	[3.034]	[1.216]	[0.716]
HR less $_{>2sd}$	-16.787***	-5.755*	-16.284**	-6.998***
	[5.889]	[3.310]	[7.724]	[2.195]
BK more $_{>2sd}$	6.635***	8.664***	9.630***	12.131***
	[1.470]	[2.881]	[2.361]	[2.761]
BK more $_{<2sd}$	0.084	1.819	3.978**	3.990***
	[0.967]	[1.803]	[1.987]	[1.473]
BK more $_{<1sd}$	0.496	-0.169	-0.364	2.103**
	[1.281]	[1.312]	[1.261]	[0.922]
BK less $_{<1sd}$	-3.813*	-3.899	-2.398	-0.692
	[1.960]	[2.414]	[1.799]	[0.920]
BK less $_{<2sd}$	-16.039**	-17.002***	-6.223**	-5.829***
	[7.546]	[6.483]	[2.954]	[1.787]
BK less $_{>2sd}$	30.715	-11.886	-20.580*	-3.843
	[22.909]	[18.811]	[11.672]	[3.269]
Obs.	10,914	10,914	10,914	10,914
R^2	0.199	0.178	0.191	0.168

Second step OLS estimates for a balanced panel domestic manufacturing firms with at least five employees in the period 1998-2005. Regressions include time, industry and region dummies; control variables included are downstream demand, industry concentration, firm age, firm size, import competition, export intensity, the share of intermediate supply in total industry output and services spillovers. Standard errors in brackets are clustered at the industry-year level. ***/**/* denotes significance at 1/5/10 percent.