Spillovers from Multinationals to Heterogeneous Domestic Firms: Evidence from Hungary

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NON-TECHNICAL SUMMARY

It is widely believed that multinational firms increase competition, transfer technology and help to achieve more efficient allocation of resources. Inward Foreign Direct Investment (FDI) is often seen as a catalyst for development by many governments because it increases domestic firms' productivity by creating linkages between multinational and domestic firms. This explains various programs that Governments in Central and Eastern European countries have launched to attract FDI in the early nineties.

Firms cluster their economic activities to exploit technological and informational spillovers from other firms. Spillovers from multinational firms can be particularly beneficial to domestic firms especially in less developed economies, because technological superiority and management experience of foreign multinational firms should theoretically yield various opportunities for learning. The empirical literature on FDI spillovers finds however mixed support concerning the impact of spillovers on domestic firms' total factor productivity (TFP).

Certainly, firms react to foreign presence in a rather heterogeneous manner. According to a recent survey conducted by the World Bank among Czech and Latvian firms, 23 per cent of firms state that the presence of multinational firms enhances their knowledge about new technologies, 13 per cent state the enhancement of their marketing know-how. However, about 29 per cent of the domestic respondents consider inward FDI to be responsible for their loss of market share.

We expect a similar pattern for Hungarian firms. Some domestic firms can reap spillovers from multinationals, but others may not. We argue that the impact multinationals have on domestic firms depends on (i) the intensity of the linkage, (ii) domestic firms' absorptive capacity and (iii) their ability to face competition. The competitive pressure from multinational firms could be the starting point for a positive development if it raises process and product innovations (Aghion et al., 2005). It could turn out to be negative for domestic firms if they just lose their market share. The liberalization process in Hungary could have increased competition, pushing some domestic firms to exit the market and others to innovate. Our aim is to analyse the different responses of heterogeneous domestic firms to the expansion spread of multinational firm presence in Hungary.

We use a large and extensive dataset on Hungarian manufacturing firms. It contains information on domestic and export sales and on the ownership structure of all firms. Further, we have information on employment, capital and other firm-level characteristics that enable us to compute the TFP of each domestic firm. We work with an unbalanced panel of manufacturing firms for the period 1992-2003.

Our empirical analysis makes use of variables that have to be constructed in a first step. First, we compute the TFP of domestic Hungarian firms using the semi-parametric Olley and Pakes (1996) methodology. Second, we construct horizontal and vertical linkage variables following Javorcik (2004). Our linkage variables differ slightly because we take the extreme view that spillovers from multinationals can only be reaped by domestic firms located in the same county, whereas (for a small country) she assumed country-wide spillovers. Thus, we assume that spillovers are generated only if geographical

distance between multinational and domestic firms is small, as has been suggested by Audretsch and Feldman (1998).

We estimate the effect of linkages with foreign multinational firms on the average domestic firm's TFP using a firm fixed-effects panel model. The firm-specific effects allow us to control for the firm's technology, thereby isolating the spillover effects. Then, we look at the difference in the spillover effect from linkages for firms that differ in productivity by estimating simultaneous quantile regressions. We follow Girma et al. (2008) and analyse the effect of spillovers on the domestic firm's TFP for exporters and nonexporters separately.

We find that horizontal spillovers affect positively the productivity of the average domestic firm that sales locally. We do not find robust evidence of forward spillovers for this firm. However, the TFP of the average Hungarian exporter is affected positively by backward spillovers. More importantly, we find that horizontal spillovers benefit the most productive firms but affect negatively the productivity of the least productive firms. We find strong evidence of positive effects of backward linkages for medium and high productivity firms. There are no robust evidence of heterogeneous effects of forward spillovers on Hungarian firms.

ABSTRACT

Technological and informational spillovers from multinational firms can be particularly beneficial to domestic firms especially in less developed economies. The technological superiority and management experience of foreign multinational firms yield various opportunities for learning. Yet, the importance of foreign firm's spillovers might vary with respect to the different intensities of the linkage between the multinational and the domestic firm, the differences in firms' absorptive capacity and their ability to face competition. We show using firm-level Hungarian data that positive spillovers from multinationals depend on the level of productivity and the exporting status of the domestic firm. Larger and more productive firms are more able to reap spillovers from multinationals than smaller and less productive firms. The export status, in contrast, is of minor importance.

JEL Classification: F23, D21, D24, R12, R30.

Keywords: FDI. Multinationals. Productivity. Spillover. Quantile regression.

ENTREPRISES MULTINATIONALES ET EFFETS D'ENTRAINEMENT: APPROCHE PAR L'UTILISATION DE DONNÉES DE FIRMES HONGROISES

RÉSUME NON TECHNIQUE

Les entreprises localisent souvent leurs activités dans certaines régions afin d'exploiter des externalités technologiques et informationnelles. Les externalités liées à l'activité des entreprises multinationales peuvent être bénéfiques aux firmes domestiques, notamment dans les pays moins développés. La supériorité technologique et l'expérience managériale des multinationales étrangères devraient théoriquement augmenter les opportunités d'apprentissage. Les résultats empiriques sont en revanche plus mitigés. L'impact des effets d'externalité sur la productivité totale des facteurs de la firme domestique (PTF) n'est pas forcément positif et/ou économiquement important.

Les entreprises réagissent de manière différente à la présence d'entreprises multinationales étrangères, Selon une récente enquête de la Banque Mondiale sur les entreprises tchèques et lettones, 23% des entreprises interrogées affirment que la présence d'entreprises multinationales leur permet un accès à de nouvelles technologies, 13% pensent qu'elle affecte favorablement leur savoir-faire en marketing. Cependant, 10% d'entre elles pensent que les IDE entrants sont responsables de leur perte en parts de marché.

Certaines entreprises domestiques sont donc capables de bénéficier de la présence de multinationales étrangères alors que d'autres ne le sont pas. Nous montrons que pour la Hongrie les effets bénéfiques (ou non) varient selon (i) la nature en amont ou en aval du lien de sous-traitance entre la multinationale et la firme domestique, (ii) la capacité des entreprises domestiques à absorber de nouvelles technologies et (iii) leur aptitude à faire face à la concurrence.

La pression concurrentielle qu'exercent les entreprises multinationales a des effets plutôt ambigue. De manière théorique, elle est à l'origine de la croissance de la productivité des entreprises domestiques si elle accroît l'innovation (Aghion et al., 2005). Cependant, la conccurence induite par l'entrée des entreprises multinationales peut aussi un effet négatif sur les entreprises domestiques si celles-ci perdaient des parts de marché. Le processus de libéralisation en Hongrie a augmenté la concurrence, entrainant certaines entreprises à sortir du marché et d'autres à innover.

RÉSUMÉ COURT

Les externalités technologiques et informationnelles liées à l'activité des entreprises multinationales peuvent être bénéfiques aux firmes domestiques notamment dans les pays moins développés. La supériorité technologique et l'expérience managériale des multinationales étrangères accroissent entre autres, les opportunités d'apprentissage. Cependant, ces effets bénéfiques varient selon la nature en amont ou en aval du lien de sous-traitance entre la multinationale et la firme domestique, de la capacité des entreprises domestiques à absorber de nouvelles technologies et de leur aptitude à faire face à la concurrence. Nous montrons à l'aide d'un échantillon d'entreprises hongroises que les effets d'entrainement des multinationales varient selon la productivité de l'entreprise domestique et son statut à l'exportation.

Les entreprises les plus productives bénéficient plus largement des effets d'entrainements que les firmes les moins productives. Le statut à l'exportation est au contraire de moindre importance.

Classification JEL : F23, D21, D24, R12, R30.

Mots clés : IDE,. Firmes Multinationales. Productivité,. Effet d'externalités. Régression quantile.

SPILLOVERS FROM MULTINATIONALS TO HETEROGENEOUS DOMESTIC FIRMS: EVIDENCE FROM HUNGARY[1]

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1. INTRODUCTION

It is widely believed that multinational firms increase competition, transfer technology and help to achieve more efficient allocation of resources (UNCTAD, 2001). Inward Foreign Direct Investment (FDI) is often seen as a *catalyst for development* by many governments because it increases domestic firms' productivity by creating linkages between multinational and domestic firms. That explains various programs that Governments in Central and Eastern European countries have launched to attract FDI in the early nineties. This is particularly the case of the Hungarian Government which has provided various subsidies and tax incentives to attract FDI since the early nineties.[2]

The empirical literature on FDI spillovers finds however only mixed support concerning the impact of spillovers on domestic firms' total factor productivity (TFP) Görg and Greenaway (2004). A part of the literature investigates the extent of *horizontal* productivity spillovers that

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[2]See Sass (2003) for a detail discussion on various programs offered by the Hungarian Government and MNB (2007) for more details on FDI in Hungary. The Hungarian FDI agency, ITD-Hungary, provides online many evidence on policies directed toward inward FDI: www.itdh.hu.

arises between multinational and domestic firms in the same industry. Using firm-level data for several transition countries, Damijan et al. (2003) find some evidence for positive spillovers only for Romania. Javorcik (2004) extends the analysis to *vertical* spillovers that occur between buyers and suppliers in different industries. Using firm-level panel data for Lithuania from 1996 to 2000, she finds evidence of *backward* spillovers, which are generated when multinationals serve customers in upstream industries. There is, however, no robust evidence that lithuanian firms benefit from *forward* spillovers, i.e linkages toward downstream industries. Blalock and Gertler (2005) find the same evidence using Indonesian plant-level data.[3]

Certainly, firms react to foreign presence in a rather heterogenous manner. According to a recent survey conducted by the World Bank[4] among Czech and Latvian firms, 23% of firms state that the presence of multinational firms enhances their knowledge about new technologies, 13% state the enhancement of their marketing know-how, and 5% find access to better employees. Less than 10% of firms reported that the foreign presence allows for a better input mix. In fact, about 46% of multinational firms report to rely on global suppliers. However, about 29% of the domestic respondents consider inward foreign direct investment to be responsible for their loss of market shares.

We expect a similar pattern for Hungarian firms. Some domestic firms can reap multinationals' spillovers, but other may not. The impact multinationals have on domestic firms depends on (i) the intensity of the linkage, (ii) domestic firms' absorptive capacity, and (iii) their ability to face competition. The competitive pressure from multinational firms could be the starting point of a positive development if it raises process- and -product innovations (Aghion et al., 2005). It could turn out to be negative for domestic firms if they only lose their market shares. In our empirical analysis the loss of market shares is important because it pushes up firms' average costs and therefore lowers their observed productivity level (Aitken and Harrison, 1999). The

[3]Further, Bosco (2001) finds horizontal spillbovers either insignificant, or negative for Hungary. According to Aitken and Harrison (1999) and Konings (2001), negative horizontal spillovers arise when multinational firms attract demand away from domestic firms. Driffield et al. (2003) examine the relative importance of horizontal, backward and forward spillovers using an industry-level data for UK manufacturing during 1984 - 1992. They show evidence for positive spillovers through forward linkages.

[4]as cited by Javorcik (2007)

liberalization process in Hungary, could have increased competition, pushing some domestic firms to exit the market and other to innovate. Our aim is to analyze the different responses of heterogenous domestic firms to multinational firms' expansion in Hungary.

In addition, we follow Girma et al. (2008) by considering the export status of the domestic firm. Girma *et al.* argue that exporters may avoid the competitive pressure from multinationals by selling their products abroad. They may also benefit from the presence of multinational firms either because a share of their domestic output can be supplied to multinationals or because they could source inputs from multinationals. Hence, the exporter status of domestic firms might be important for the analysis of spillovers. However, our focus is different. We analyze whether the larger observed productivity of Hungarian exporters compared to non-exporters is partly due to the presence of multinational firms.

We use a large and extensive data set on Hungarian manufacturing firms. It entails information on domestic and export sales and on the ownership structure of all firms. Further, we have information on employment, capital and other firm-level characteristics that enable us to compute the TFP of each domestic firm. We work with an unbalanced panel of manufacturing firms for the period 1992-2003.

Our empirical analysis makes use of variables that have to be constructed in a first step. First, we compute the TFP of domestic Hungarian firms using the semi-parametric Olley and Pakes (1996) methodology. Second, we construct horizontal and vertical linkage variables following Javorcik (2004). Our linkage variables slightly differ because we take the extreme view that spillovers from multinationals can only be reaped by domestic firms located in the same county, while (for a small country) she assumed country-wide spillovers. Thus, we assume that spillovers are only generated if geographical distance between multinational and domestic firms is small as has been suggested by Audretsch (1998). For Hungarian firms, our assumption is supported by Halpern and Muraközy (2005) who found strong positive spillovers to domestic firms that operate only on small distances (i.e. broadly at the county level).

We estimate the effect of linkages with foreign multinational firms on the *average* domestic firm's TFP using a firm fixed-effects panel model. The firm specific effects allow to control for the firm's technology, thereby isolating the spillovers effects. Then, we look at the difference in the spillover effect from linkages for firms that differ in productivity by estimating simultaneous

quantile regressions. We follow Girma et al. (2008) and analyze the effect of spillovers on the domestic firm's TFP for exporters and non-exporters separately.

The remainder of this paper is structured as follows. In Section 2, we present the different effect that multinationals can have on domestic firms. In Section 3, we introduce the Hungarian dataset and present some descriptive statistics. In Section 4, we present the estimation strategy. In Section 5, we discuss our results. We conclude in Section 6.

2. SPILLOVERS AND HETEROGENEITY

Our interest in the effect of firm heterogeneity on the ability to reap spillovers from foreign firms is first of all policy related. Since large foreign firms are often attracted using large amounts of tax payers money, it is important to analyze the conditions under which positive spillovers can be maximized and negative effects kept as small as possible. There are different theoretical reasons to expect the extent of spillovers to vary with productivity.

According to Findlay (1978), a greater technology gap between the most advanced and the least advanced firm allows for faster convergence of the lagging firm to the technology frontier. Many studies find that the potential to catch up is an important determinant of absorbed spillovers. Sjöholm (1999) for instance finds that FDI spillovers in Indonesia are greater in sectors with a high-technology gap. Griffith et al. (2004) study UK manufacturing and find also support for the convergence hypothesis. Moreover, they find that a higher foreign presence within a particular industry yields more rapid convergence.

Differences in the ability to close technology gaps is in the literature explained by differences in the absorptive capacity of domestic firms. *Absorptive capacity is a set of organizational routines and processes by which firms acquire, assimilate, transform, and exploit knowledge to produce a dynamic organizational capability.* (Zahra and George, 2002, p.186.) or using another definition, *firms ability to recognize valuable new knowledge, integrate it into the firm and use it productively* (Cohen and Levinthal, 1990). We argue that identification, acquisition and exploitation of new knowledge may all depend on the firm's level of productivity.

Girma et al. (2001) argue that a lack of sizable horizontal spillovers from multinationals to domestic firms might be explained by the lack of absorptive capacity of domestic firms. They

may be unable to learn from multinational firms if the technological gap between the two groups is too wide. This is supported by evidence from UK establishments, where the strength of spillovers rises in productivity (Girma and Görg, 2005).

Another channel of spillovers from multinational firms runs through the competition effect. An increase in competition might encourage innovative activities and thus enhances productivity. Aghion et al. (2005) argue that innovation that spurs competition is particularly important among peers. Given that innovation shall lead to higher productivity, some firms realize productivity gains. Firms that are near to the technological frontier are therefore most likely to reap additional gains. Technological gap and absorptive capacity can jointly explain the inverted-U relationship between competition and innovation found in Aghion et al. (2005).

Yet, competition from foreign firms may also affect negatively domestic firms' TFP. According to Aitken and Harrison (1999), the loss in market shares yields an increase of the average cost and thus reduces productivity. Thereby, domestic firms are negatively affected through the product market but also through the factor markets. Competition in factor markets drives up factor prices while goods market competition drives down good prices. Both channels lead to a lower measure of productivity since value added falls. If economies of scale exist, lower sales reduce productivity. These effects of competition from multinational firms may be similar for all firms but the least productive. These firms might be forced to exit. See Kosova (2006) for example for a study on the impact of FDI on exit of Czech firms.

In table (1), we summarize hypothesis from theoretical considerations for three groups of firms differing with respect to productivity.

Table 1 – Theoretical Considerations: Predictions.

	Least Prod.	Average	Most Prod.	Linkage type
1. Convergence	++	+	0	Hor, Vert
2. Absorptive capacity	0	0	+	Hor
3. Innovation	0	+	++	Hor, Vert
4. Competition	-/+	-/+	-/+	Hor, Vert

Spillover effects might also differ with respect to the export status of the domestic firm. Girma et al. (2008) looked at multinationals' spillovers using UK manufacturing data. Their results suggest that spillovers affect exporters and non-exporters in a different way. In particular, exporters are affected by less competitive pressure from multinational firms because part of

their output is sold on foreign markets. The effect of competition should therefore be lower for exporters than for non-exporters.

Furthermore, exporters' experience in export markets might explain why they deal better with spillovers of foreign multinational firms (Bernard and Jensen, 1999). That is particularly the case if learning is the main issue. However, it might also be possible that the foreign multinationals' spillovers at home are less important to exporters, because they also learn from firms in the foreign market. That argument holds if the catch up potential is more important.

Thus, theory does not provide unambiguous predictions on the effect, channel and importance of spillovers. Moreover, we did also not find a conclusive theoretical picture with respect to the effect of productivity of a particular firm on its ability to reap spillovers from foreign multinational firms.[5] Unfortunately, the empirical evidence on spillovers has not converged yet either (Görg and Greenaway, 2004).

3. DESCRIPTIVE STATISTICS

In this section, we describe the data and analyze the productivity distribution of Hungarian firms. Our analysis is limited to manufacturing firms. Moreover, we restrict the sample to those firms that meet certain data requirements that will be described in the first subsection. In the second subsection, we study the distribution of Hungarian firms with respect to size and productivity. As documented for other economies as well, exporters are larger and more productive than domestic firms over the whole size distribution. Foreign multinational firms are larger and more productive than Hungarian exporters. Hence, the necessary condition for learning is met. It is possible that Hungarian firms (non-exporter and exporter) learn from more productive foreign multinational firms. In the third subsection, we have a first look at the number of foreign multinational firms active in a particular Hungarian county.

[5] For surveys on export and productivity, see Wagner (2007) and Greenaway and Kneller (2007)

3.1. Data

We use a dataset of Hungarian firms, which is based on annual balance sheet data submitted to the Hungarian Tax Authority APEH[6]. The dataset contains information on *all* registered incorporated firms. The data include the information of each firm's balance sheet and income statement. It entails information on sales, employment, total assets, labor costs, and equity ownership. It also includes information on each firm's sector classification (NACE rev-1, two-digit level) and on the location of the firm's headquarter. The data covers firms' activities between 1992 to 2003.

In Hungary, economic transition has led to entry of new domestic and foreign firms. The number of firms has risen substantially from 55,213 in 1992 to 226,072 in 2003. The sample we use in this study is smaller than the original APEH data for two reasons. First, we focus on manufacturing firms. Second, we drop very small firms because their data is unreliable and incomplete on employment and fixed assets, which are required to compute the TFP variable. That reduces the sample to 108,541 observations over 12 years. The number of firms in the sample rises over the years from 6,003 in 1992 to 11,208 in 2003. This subsample covers 42% of the total number of manufacturing firms and 73% of total turnover. We use a smaller subsample that includes only the domestically-owned firms. It contains 66,470 observations from 11,767 firms for the period from 1993 to 2003. The summary statistics for all domestically-owned firms in our sample can be found in table (7) in the Appendix.

3.2. Total Factor Productivity, Domestic and International Activities

The data allows to discriminate between firms according to their export status and their foreign ownership. We differentiate between four types of firms in the APEH database: domestic non-exporting firms, domestic exporters, foreign-owned non-exporting firms and foreign-owned exporters. We define a firm that exports at least 5% of its total sales as an exporter and a firm with at least 10% foreign stake as a foreign owned firm. Our results are robust to the choice of these limits. We use the foreign ownership information to compute our horizontal and vertical

[6]We provide more information about the data in the first section of the Web Appendix; see $http$: $//econ.core.hu/\ bekes/BKT2008_{w}eb_{a}ppendix.pdf$

spillover variables.

In 2002, the sample includes 8,650 domestically owned and 2,112 foreign owned firms. Exporters account for 27% of domestically owned firms and 74.0% of foreign owned firms. The foreign presence in Hungarian manufacturing is important particularly if measured in sales. Foreign-owned Hungarian firms account for about 28.6 billion euro (76.6% of total sales in our sample) compared with about 8.7 billion euros by domestically owned firms.

We are interested in the effect of spillovers from foreign firms on domestic firms TFP. To proxy TFP, we use the firm-level residual from a production function estimated at sector level. We use the Olley and Pakes (1996) (OP) semiparametric method to estimate firm-level TFP, a method that takes into account the endogeneity of capital input, the exit of firms and unobserved time-invariant differences among firms. We assume a Cobb-Douglas production function

$$y_{it} = \beta_0 + \beta_k k_{it} + \beta_l l_{it} + \beta_m m_{it} + \omega_{it} + \epsilon_{it} \tag{1}$$

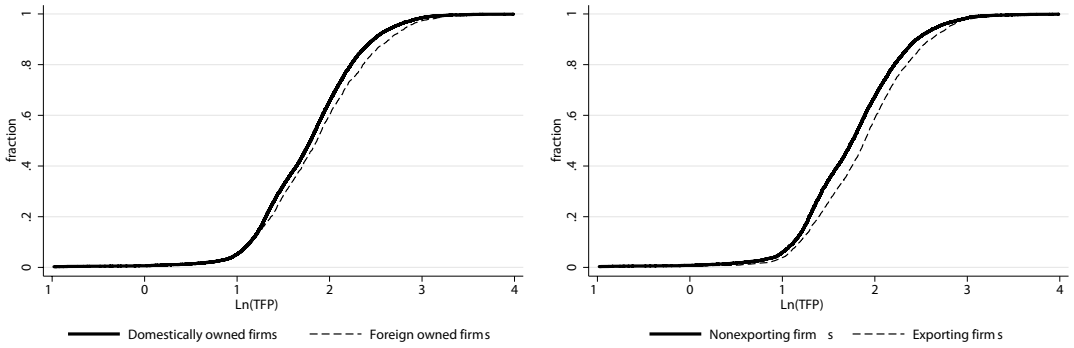
and denote the logarithm of output (total sales), fixed asset capital, labor (employment) and intermediate inputs (materials) with y_{it}, k_{it}, l_{it} m_{it}, respectively. Subscripts *i* and *t* stand for the individual firm and time, ω_{it} denotes productivity, and ϵ_{it} stands for measurement error in output. For details, see Section 2 of the Web Appendix.[7]

Before estimating spillover regressions, we first look at the productivity variation among groups. Taking sample means for the year 2000, foreign firms are more productive than domestically owned firms (1.88 vs 1.76), and exporters are more productive than non-exporters (1.89 vs 1.72). In Figure 1, we show the cumulative distribution of TFP for various groups. Panel (a) points to first-order stochastic dominance of foreign firms relative to domestically owned ones, while panel (b) suggest the dominance of exporters over non-exporters.

In Figure 2, we show the cumulative distribution of TFP and sales of domestically owned Hungarian firms according to their export status. Panel (a) of Figure 2 points to first-order stochastic dominance of Hungarian exporters with respect to sales. Exporters are selling more

[7] http://econ.core.hu/~bekes/BKT2008_web_appendix.pdf

Figure 1 – Cumulative Distribution of:



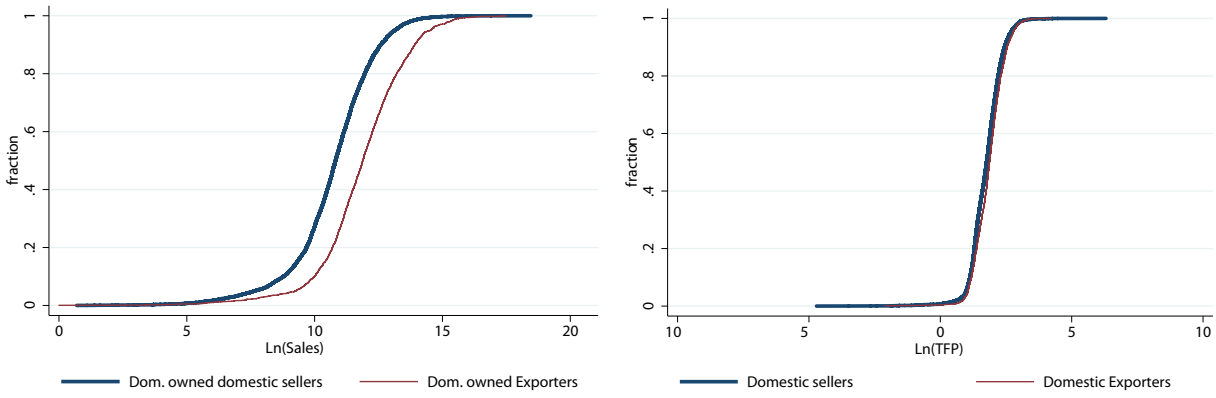
(a) **Domestic vs Foreign owned** (b) **Non-exporters vs exporters**

Source: APEH, authors' computation.

than domestic firms over the whole distribution. A first-order stochastic dominance of exporters with respect to TFP is, in contrast, not apparent from Panel (b) of Figure 2.

We use the non-parametric Kolmogorov-Smirnov test (KS-test) to determine whether the sales and TFP distributions between the two groups differ significantly. The results of the two-sided KS-test are shown in Table 2. The KS-tests reveals that Hungarian exporters are larger and more productive than domestic firms.

Figure 2 – Cumulative Distribution of:



(a) **Sales** (b) **Total Factor Productivity**

Source: APEH, authors' computation.

Table 2 – KS-Test of Differences between Exporters and Domestic firms, Sales and TFP, 2000

		Sales	
Group	Largest Difference	P-value	Corrected
$Ho: Exp - Dom \leq 0$	0.3034	0.000	
$Ho: Dom - Exp \leq 0$	-0.0005	0.999	
Combined K-S	0.3034	0.000	0.000
		TFP	
Group	Largest Difference	P-value	Corrected
$Ho: Exp - Dom \leq 0$	0.0918	0.000	
$Ho: Dom - Exp \leq 0$	-0.0014	0.995	
Combined K-S	0.0918	0.000	0.000

Concerning the sales distribution, the largest difference between the distribution functions is 0.3034, which is statistically significant at 1%. Thus, the null hypothesis that both sales distributions are equal is rejected. From the left hand-side of the KS-test we can reject the hypothesis that domestic firms are larger than exporters with respect to their sales. The largest difference between the distributions functions is 0.3034, which is statistically significant at 1% level of significance. From the right hand-side of the KS-test, we can not reject the hypothesis that exporters are larger than domestic firms. The largest difference between the distributions functions is -0.0005, which is not significant. Therefore, we cannot reject the stochastic dominance of exporters' sales distribution over domestic firms' sales distribution. However, we can reject the stochastic dominance of domestic firms' sales distribution over exporters' sales distribution.

We find qualitatively similar results using the TFP distributions. Exporters' TFP cumulative distribution with respect to TFP dominates stochastically domestic firms' TFP cumulative distribution. As result, the KS-test of stochastic dominance suggests that exporters are more productive than domestic firms and larger in size.[8]

3.3. TFP and Foreign Spillovers

Having documented that Hungarian exporters are more productive than domestic firms, we now turn to the most productive firms in Hungary: foreign multinational firms.

Transition countries in general, and Hungary in particular, offer a laboratory environment for studying spillover effects because the presence of foreign firms is rather impressive. Transition

[8]The KS-test results are qualitatively similar for each year of the sample.

started before 1992 the starting point of our sample. Foreign firms entered Hungary as early as the 1989 through joint ventures and greenfield investment. The share of foreign production in manufacturing reached as much as 30% in 1992 already.

We examine whether domestic Hungarian firms (non-exporters and exporters) use their proximity to foreign multinational firms to learn from them or to increase their productivity in another way. We therefore first look at the productivity gap. Recall that theory proposed two opposite effects of a productivity gap on spillovers from multinational firms. First, a productivity gap is the first necessary condition for learning. The larger the gap the higher is the potential for the lagging firm. Second, the ability to reap positive spillovers from interaction with multinationals might depend positively on domestic firm's productivity.

We use again the KS-test to determine whether the sales and TFP distributions of foreign owned and domestically owned firms differ significantly. We present the comparison of foreign owned firms and the group of Hungarian exporters. The results of the two-sided KS-test are shown in Table 3. The KS-test reveals that the TFP distribution of foreign multinational firms stochastically dominates those of Hungarian exporters. Thus, there is a gap between Hungarian and multinational firms with respect to TFP.

Table 3 – KS-Test of Differences between foreign multinational firms and Hungarian Exporters. TFP, 2000

		TFP	
Group	Largest Difference	P-value	Corrected
$Ho: MNE - Exp \leq 0$	0.0474	0.020	
$Ho: Exp - MNE \leq 0$	-0.0111	0.809	
Combined K-S	0.0474	0.041	0.037

Yet, we expect spillovers not only to depend on domestic firms' productivity but also on the intensity of interactions with multinationals. We expect these interactions to decrease in distance and assume for our empirical analysis that interactions take place only between firms located in the same county. As seen in Table 4, the regional distribution of FDI is rather heterogenous. Most of the foreign firms are located in Western counties whereas the peripheral counties in the North-East are less attractive.

Table 4 – Hungarian counties' characteristics (2000)

County	Location	Population ('000)	GDP per capita 2000	Number of foreign firms, 2000	Share of foreign firms
Vas	W	267	114.3	142	28.8%
Györ-M.-S.	NW	440	134.2	246	26.1%
Zala	W	297	83.8	122	23.1%
Komárom-E	Cen/N	316	83.5	145	18.8%
Veszprém	W	368	84.2	128	17.9%
Baranya	S	402	75.7	146	16.5%
Tolna	Cent/S	247	81.3	64	16.4%
Nógrad	N	218	54.1	54	15.2%
Bács-K.	Cent/S	542	66.4	156	14.4%
Heves	Cent/E	324	71	78	13.9%
Somogy	SW	334	67.1	56	13.7%
Fejér	Cent/W	428	119	108	12.7%
Budapest	Cent	1708	202.7	1074	11.7%
Csongrád	S	426	82.4	95	11.5%
Békés	SE	393	65.6	57	10.9%
Pest	Cent	1123	78.3	322	10.2%
Borsod-A-Z	NE	738	64.1	110	9.8%
Szabolcs-Sz.-B.	NE	583	53.5	62	9.8%
Jász-N-Sz	Cent/E	413	66.3	60	9.2%
Hajdú-B.	E	550	71.2	66	6.7%

4. EMPIRICAL ANALYSIS

We want to explain systematic variation in firms' TFP by spillovers from multinational firms which are not observable. We expect spillovers to stem from linkages with foreign multinational firms and proxy therefore the potential of spillovers by the share of multinational firms per county.

4.1. Horizontal and Vertical Spillovers

The total factor productivity of a firm reflects its technology. Apart from its own technology, the productivity of a firm might also be affected by sectoral linkages and local competition. In this study, we examine the effect of horizontal linkages, of backward and of forward linkages and of local and sectoral competition on firm-specific productivity. Thereby, we describe the logarithm of the TFP of a domestic firm *i*, in sector *j* located in a county *l* at time *t*, TFP_{ijlt}, by equation (2)

$$TFP_{ijlt} = \alpha H_{jlt} + \beta_1 B_{jlt} + \beta_2 F_{jlt} + \gamma C_{jlt} + \chi Psh_{it} + \nu_i + \nu_j + \nu_t \quad (2)$$

TFP_{ijlt} has been computed using the semi-parametric estimation suggested by Olley and Pakes (1996). The methodology is explained in Section 2 of the Web Appendix. It allows to take into account the endogeneity of the inputs in the production function. The endogeneity issue arises because inputs are chosen by a firm based on its productivity.

H_{jlt}, B_{jlt}, F_{jlt} and C_{jlt} represent local ***H***orizontal, local ***B***ackward and ***F***orward linkages and local and sectoral ***C***ompetition, respectively. We focus on spillovers and competition within a specific county and assume that they arise from the presence of multinational firms in the same county. The variable Psh_{it} stands for the ***P***rivatization ***sh***are at firm-level (which can change year by year). Since we want to quantify the impact of spillovers at sectoral level on firm-specific total factor productivity, we control for the technology of the firm by introducing firm-specific effects, ν_i. Since the firm specific TFP might also be driven by unobserved sectoral specific shocks, we include a set of sector dummy variables, ν_j. We also assume that firm-specific TFP is affected by macroeconomic shocks and include a set of time dummy variables ν_t to control for it. In addition, the time dummy variables control for the average change of productivity that is not due to the spillovers.

Horizontal spillovers occur when entry or presence of multinational firms lead to an increase in productivity of domestic firms active in the *same* industry. They result, for instance, from intra-sectoral movement of workers who take some industry-specific knowledge with them. As in Javorcik (2004), we assume that horizontal spillovers increase with the foreign presence in sector *j* at time *t*. We assume, however, that horizontal spillovers are county-specific. We proxy the potential for spillovers by the share of multinational firms in total activities. For each county *l*, H_{jlt} is defined as foreign equity participation averaged over all firms in the sector, weighted by sector output in the county. Thus, we define horizontal linkages H_{jlt} as

$$H_{jlt} = \left[\sum_{i \in j,l} share_{it} * Y_{it} \right] / \sum_{i \in j,l} Y_{it} \quad (3)$$

where $share_{it}$ is the share of firm's total equity that is foreign owned. Y_{it} is the output of firm *i* at time *t*.

Vertical spillovers can arise from multinational firms' presence in backward or forward industries. Linkages with suppliers and customers might increase the efficiency of a firm. We compute backward linkages with multinational firms (i.e. domestic firms supply of foreign firms) as

$$B_{jlt} = \sum_{k \neq j,l} \theta_{jk} H_{klt} \tag{4}$$

where θ_{jk} is the fraction of industry *j*'s output shipped to sector *k*. This information is taken from the 1998 input-output table at the two-digit NACE level.[9] As in Javorcik (2004), the output shipped within the sector is excluded in the computation since this effect is already captured by the horizontal spillovers variable.

Forward linkages (i.e. domestic firms purchase goods from foreign firms) are defined as the weighted foreign share in output in the supplying industries.

$$F_{jlt} = \sum_{m \neq j,l} \theta_{mj} H_{mlt} \tag{5}$$

θ_{jm} is the share of inputs purchased by industry *j* from industry *m* in total inputs purchased by industry *j*. We again exclude the input purchased within the sector because these linkages are captured by the horizontal spillovers variable.

We capture a potential competition effect by the Herfindahl index that measures concentration within an industry. We calculate the Herfindahl indices for all year, sector and county combinations and denote it by C_{jlt}. Because of the ambiguous effects of competition on TFP, we do not have priors on the expected impact of the Herfindahl index. The mode of ownership might also influence the TFP of domestic firms. As documented in Brown et al. (2006), privately owned firms are more efficient than state-owned firm. We therefore control for the mode of ownership at firm level by including the privatization share.

[9]The results do not change if we the use the revised 2000 version to compute the linkage variables.

4.2. Estimation Strategy

The heterogeneity in the firm-level data is large. This suggests that we should not start from the assumption of a representative firm. We take therefore the heterogeneity explicitly into account when studying the effects of multinational spillovers on domestic firms. We deal with it in our empirical analysis in two ways. First, we look at the *average* impact of spillovers and competition on domestic firms. Therefore, we use a firm fixed-effects panel model. While firm heterogeneity is collected in the firm fixed effects, coefficients of H_{jlt}, B_{jlt}, F_{jlt} and C_{jlt} give the average effects of spillovers and competition. Thus, we first ignore differences in the effect of spillovers and competition among firms but control for firm-level heterogeneity by including firm fixed effects. Second, we allow spillovers and competition effects to differ between well defined groups of firms but not among firms within each group. We do this by estimating a simultaneous quantile regression model. Unlike the least squares estimator that assumes covariates shifting the location of the conditional distribution only, quantile regression allows us to analyze the possible effects on the shape of the TFP distribution.

In fixed-effects specifications, heteroscedasticity and serial correlation are always potential problems. The possible bias is larger the longer the time horizon. Since we have short time-series and a large cross-section, it is appropriate to use cluster-sample methods (Wooldridge, 2003; Arellano, 1987) to estimate the fixed-effects model. Cluster-sample methods are a generalization of White's (White, 1980) robust covariance matrices. The obtained robust variance matrix estimator is valid in the presence of heteroscedasticity and serial correlation provided that, as in our case, T is small relative to the number of groups (Wooldridge, 2002, 2003). The fixed effects panel estimation controls for the unobserved heterogeneity among domestic firms in the sample.

The simultaneous quantile regression methodology allows a closer look at the impact of the spillovers on the productivity of domestic firms. We split the firms into twenty groups sorting them with respect to their productivity. We assume that firms within each group are affected identically by spillovers and by competition while the effect between groups might vary. Hence, we test whether spillovers and competition have a different effect on different groups. The bootstrapped variance-covariance matrix takes into account the errors correlation between the different quantiles and allows us to compare coefficients of the explanatory variables in the dif-

ferent quantiles (Koenker and Hallock, 2001). We estimate a simultaneous quantile regression model, which is specified as

$$Quant_{\Theta}\left(TFP_{ijlt}|X_{ijlt}\right) = X'_{ijlt}\beta_{\Theta} \tag{6}$$

where X_{ijlt} is the vector of independent variables specified in equation (2) and $Quant_{\Theta}\left(TFP_{ijlt}|X_{it}\right)$ the conditional quantile of TFP. The distribution of the error term ν_{ijlt} is left unspecified so the estimation method is essentially semiparametric. Koenker and Bassett (1978), introducing this technique, show that β_{Θ} can be estimated by

$$min_{\beta}\{\sum_{ijlt:TFP\geq X'\beta}\Theta|TFP_{ijlt}-X'_{ijlt}|+\sum_{ijlt:TFP<X'\beta}(1-\Theta)|TFP_{ijlt}-X'_{ijlt}|\} \tag{7}$$

The main advantage of the quantile regression approach is that it allows different slope coefficients to be estimated for different quantiles of the conditional distribution of the TFP variable. Since Θ varies from 0 to 1, we trace the entire distribution of TFP conditional on the set of independent variables. As emphasized in Girma et al. (2004), quantile regressions provide a robust alternative to OLS when as in our case, the error terms are non-normal. The tests of normality of the TFP distribution, as well as a skewness and kurtosis test, reject the log-normal distribution of TFP. Tests of normality reject a log-normal distribution of establishment-level TFP for any given year and for all domestic-owned firms.[10]

5. RESULTS

We first present the results from the fixed effects regressions discussing the effect of spillovers from multinational firms and a firm's export status on the productivity level of a particular firm. We compare the results to Javorcik (2004) and Girma et al. (2008). Then, we turn to the quantile regressions also presenting results for the whole sample and domestic firms and exporters separately.

[10]The Shapiro and Francia test (Shapiro and Francia, 1972), designed for a smaller sample size, yields a p-value of 0.000 to 0.013 for any given year and a p-value of 0.000 for all but two sectors, while the skewness and kurtosis test of D'Agostino et al. (1990) for the whole sample gave a p-value of 0.000.

Table 5 – Firm-Level Fixed Effects Panel Regression - Dependent Variable:$lnTFP$

	Labels	(S1)	(S2)
Horizontal Spillovers	H_{jlt}	0.0411**	
		(2.41)	
Backward Spillovers	B_{jlt}	-0.0047	
		(0.10)	
Forward Spillovers	F_{jlt}	0.0392	
		(1.38)	
Herfindahl Index	C_{jlt}	-0.0684**	-0.0660**
		(2.41)	(2.34)
Privatization Share	Psh_{it}	0.0660***	0.0660***
		(4.25)	(4.26)
Horizontal Spillovers×Exporter	$H_{jlt} \times Exp$		0.0344
			(1.64)
Backward Spillovers×Exporter	$B_{jlt} \times Exp$		0.1681***
			(2.60)
Forward Spillovers×Exporter	$F_{jlt} \times Exp$		0.0181
			(0.55)
Horizontal Spillovers×Non-exporter	$H_{jlt} \times Dom$		0.0437**
			(2.36)
Backward Spillovers×Non-exporter	$B_{jlt} \times Dom$		-0.0545
			(1.10)
Forward Spillovers×Non-exporter	$F_{jlt} \times dom$		0.0426
			(1.44)
Time Fixed Effects		Yes	Yes
Observations		66470	66470
Number of groups		11767	11767
Within R-squared		0.01	0.011

Robust t-statistics in parentheses.
Standard errors have been adjusted for clustering around the firm's identity.
*** denotes statistical significance at one percent level od significance.
** denotes statistical significance at five percent level of significance.
* denotes statistical significance at ten percent level of significance.

5.1. Average Impact of Spillovers on Domestic Productivity

We estimate the average impact of the spillover variables on the domestic firm using a firm fixed effects panel model. The results are presented in Table 5. In the first specification (S1), we show the results of the spillovers and the competition effect on the average Hungarian firms without separating non-exporters and exporters. In the second specification (S2), we interact the average impact of spillovers on TFP with the exporting status of the firm.

Specification (S1) of Table (5) shows that the average impact of horizontal spillovers is positive and significant. Therefore, potential technology transfers from multinationals to domestic firms in the same sector outweighs the competition effect that arises from the multinational presence.

An alternative explanation comes from the negative and significant impact of the Herfindahl index on TFP. Given the Herfindahl index, the additional competition generated by foreign firms increases productivity. It is however impossible to distinguish between these two alternative explanations.[11]

Concerning vertical spillovers, backward and forward linkages have non-significant impact on firm's average TFP. Both the significant positive effect of horizontal spillovers and the insignificant effect of vertical spillovers differ from Javorcik (2004) results on Lithuanian firms.

Moreover, as found in Brown et al. (2006), the firm-level privatization share has a positive and significant impact on TFP. The coefficients of the Herfindahl index and the privatization share variables are robust to the inclusion of the interaction terms between the spillover variables and the export status dummy variables.

As in Girma *et al.* (2008) and Javorcik (2004), we fail to identify statistically significant forward spillovers. However, we find that horizontal spillovers affect exporters and non-exporters positively, but the effect is not significant for exporters. Contrary to results of Girma *et al.* (2008) for the UK, it seems that local competition from multinational firms stimulate innovation among domestic Hungarian firms that sell locally. This is in line with the theoretical and empirical results by Aghion *et al.* (2005). While Girma *et al.* find mixed evidence on the effect of backward spillovers, we find that they benefit only to the exporters. The effect is negative but not statistically significant for domestic firms.

5.2. Impact of Spillovers on Heterogenous Domestic Firms

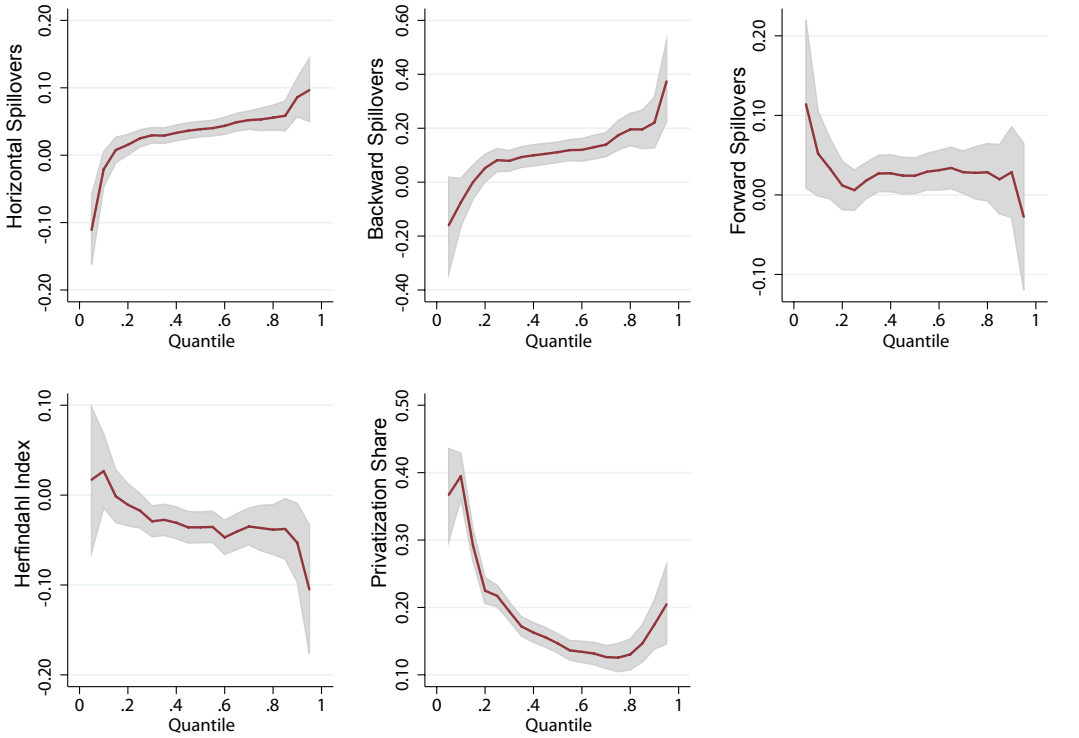
In this subsection, we use quantile regression techniques to study how different productivity levels affect spillovers from foreign multinational firms. The fixed effect regressions infer the average effect on a Hungarian firm. Yet, if firms ability to benefit from foreign multinationals is very different, the average might not be very informative. If the ability changes with the firms' productivity level, quantile regression allow to estimate group-specific effects.

We split the distribution of the logarithm of TFP in twenty quantiles and estimate a simultaneous quantile regression. We assume therefore that spillovers and competition effects differ

[11] We owe this point to an anonymous referee.

between groups of firms but not within each group. The estimation results are presented in Figure (3). In each subfigure, we present the estimated coefficient of each variable on the vertical axis and the corresponding quantile of $lnTFP_{ijlt}$ on the horizontal axis. The first quantile of the distribution contains information on the least productive firms, while the last quantile contains information on the most productive firms.

Figure 3 – Simultaneous Quantile Regression: Dependent Variable $lnTFP_{ijlt}$



Estimated coefficient on the vertical axis. Quantile of $lnTFP_{ijlt}$ on the horizontal axis. Source: APEH, authors' computation.

Figure 3 shows that horizontal spillovers have a negative impact on the least productive firm. The effect is significantly positive in contrast for the most productive firm. Moreover, the effect increases monotonically over the whole distribution of TFP. Based on the theoretical considerations from above, we suspect two possible reasons for this finding. First, absorptive capacity in learning is more important than catch-up potential in our analysis. The negative effect on the least productive firm stems from their low level of absorptive capacity. Second, in line with Aghion et al. (2005) competition from multinational firms stimulates innovation among domestic firms that have high level of productivity. Hence, we argue that the larger the productivity gap between the domestic and foreign firms, the less likely is the domestic firms

to gain from foreign multinational firms in its own sector.

The picture for backward spillovers looks very similar. We find a negative impact of backward spillovers on the least productive firm, whereas this impact is positive and significant for the more productive firms. The positive impact of backward linkages is increasing with the productivity of the domestic firm. Multinational firms might have stronger linkages to more productive firms in their downstream sectors. These firms are provided with knowledge in order to obtain higher quality or less expensive goods. Moreover, increasing foreign presence in the upstream sectors redirects intermediate inputs supply away from least productive firms toward more productive firms in the downstream sector. Horizontal and backward spillover effects increasing in domestic firms' productivity is in line with Girma et al. (2004) findings on UK establishment.

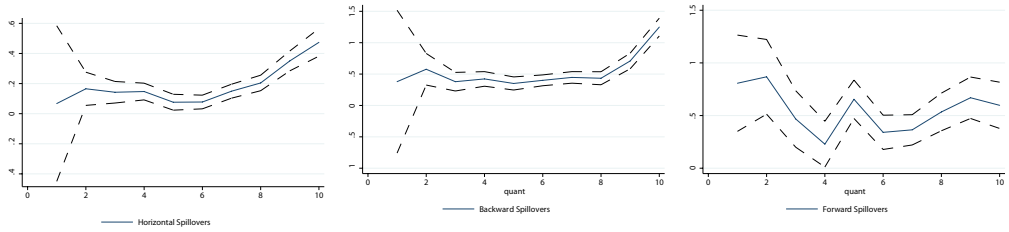
Contrary to Javorcik (2004), we find a positive although small impact of forward spillovers on the productivity of domestic firms. The effect is larger for the least productive firms and insignificant for the most productive firms. The positive effect might stem from a higher quality of inputs purchased from multinational firms.

The Herfindahl index has a positive but insignificant impact on the least productive firms and a negative impact on TFP of more productive firms. Finally, the results suggest a positive correlation between the privatization share and the level of productivity of domestic firms. The impact of privatization is larger the less productive the domestic firm is.

Spillovers might take time to exercise their impact on TFP. For example, an increase of output by foreign firms may lead to increased interaction with domestic firms at time t, but it is only in time $t + 1$ when this relationship bears fruit. Thus, we ran our basic regression with all spillover variables lagged by one year. Results given in Figure 2 of the Web Appendix do not differ much. If anything, the "slope" of the backward spillover variable seems slightly stronger.

As a robustness check, we split the distribution of the logarithm of TFP into 10 deciles and run fixed effect panel regressions for each deciles. Basic results are presented in Figure 4. They confirm that more productive firms reap greater benefit from backward and to a less extent horizontal spillovers than less productive firms.

Figure 4 – Fixed effect panel regression by deciles: Dependent Variable $lnTFP_{ijlt}$



(a) **Horizontal** (b) **Backward** (c) **Forward**

Estimated coefficient on the vertical axis. Quantile of $lnTFP_{ijlt}$ on the horizontal, confidence intervals denoted with dashed line. Source: APEH, authors' computation.

5.3. Impact of Spillovers on Exporters and Non-exporters

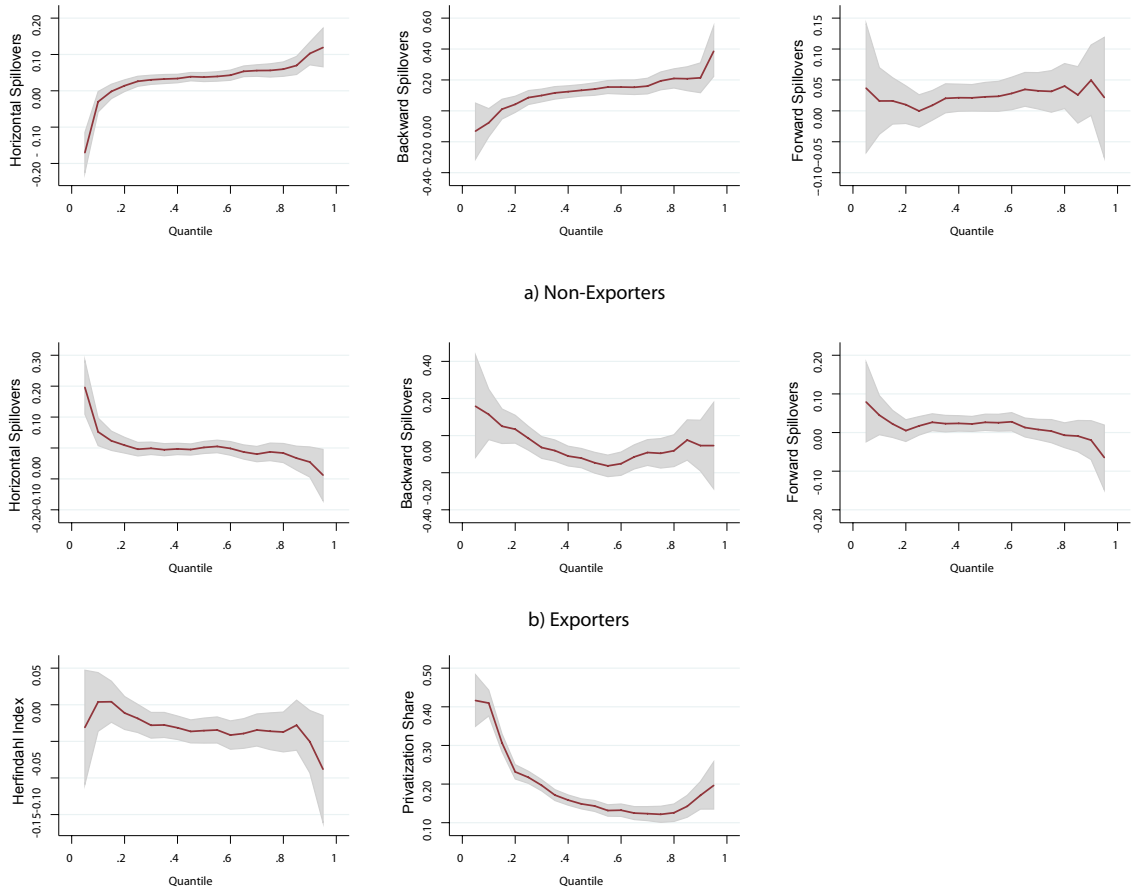
Finally, we separate the effect of spillovers from multinational firms on exporters and non-exporting domestic firms by additionally including an interaction term between the spillovers variables and an exporter dummy variable and a non-exporter dummy variable, respectively.

The results are reported in Figure 5. The upper panel of Figure 5 show the coefficients of spillovers from multinational firms to domestic non-exporting firms. Figure 3 and the upper panel of Figure 5 are very similar. That suggests that the effect on all Hungarian firms is mainly driven by the non-exporting firms. The middle panel shows the coefficients of the spillovers effect on exporters. The bottom panel shows the coefficients of Herfindahl index and of the privatization share variables.

We can statistically distinguish differences in the impact of spillovers from multinational firms by the export status of domestic firms for some quantiles. Most non-exporting Hungarian firms receive horizontal spillovers from multinational firms. We find that the least productive exporters benefit from horizontal spillovers. Yet, these spillovers do not affect the productivity of most exporters. Since a fraction of exporting firms' sales is made in foreign markets, exporters face less competitive pressure from foreign firms in their domestic markets than non exporters (Girma *et al.*, 2008). Horizontal spillovers are therefore lower for exporters.

With respect to backward linkages, the panel in the second column show that non-exporters gain from positive spillovers if their productivity places them at least in the third decile. Exporters' pattern has a slight u-shape, but significant gain from productivity takes place in the upper third of the distribution only. Forward spillovers are very similar for the two groups. They are

Figure 5 – Simultaneous Quantile Regression: Dependent Variable $lnTFP_{ijlt}$



Estimated coefficient on the vertical axis. Quantile of $lnTFP_{ijlt}$ on the horizontal axis. Source: APEH, authors' computation.

slightly positive or zero.

The productivity advantage of exporters that we reported in Section 3 does therefore not result from higher spillovers that exporters as such receive from multinational firms relative to non-exporters.

Supporting the results from the fixed effects regression, the quantile regressions revealed no larger spillovers for exporters than for non-exporting domestic firms -once a generically higher TFP is controlled for. Hence, larger spillovers from multinational firms are not a reason for the higher TFP of exporters. Thus, exporters might receive additional spillovers in the foreign market which increases their TFP, but we did not find support for higher spillovers received by exporters at home.

There are two possible explanations for these findings. First and probably most important,

the higher TFP of exporting firms relative to non-exporters is explained by the fact that more productive firms self-select into exporting (as in Melitz, 2003) Thus, exporting status *per se* gives no reason for a difference in the effect of spillovers in addition to the higher TFP level of exporters. Second, exporters might receive additional spillovers in the foreign market which increase their TFP but do not show up in above average spillovers in Hungary.

6. CONCLUSIONS

We examine the impact local foreign multinationals' spillovers for the productivity of Hungarian firms. We use a sample of $11,767$ Hungarian firms and their activities between 1993 and 2002. We analyzed how Hungarian firms' productivity respond to the expansion of multinationals firms in Hungary.

We document heterogeneity among Hungarian firms with respect to their productivity and analyzed whether more productive and larger firms are able to reap more benefit from spillovers of multinational firms. We used simultaneous quantile regression to analyze whether the effect of multinationals' spillovers between different groups of productive firms. We found significant differences among groups. The presence of multinationals in the same industry increase competition on goods and factor markets and reduces the productivity of the least productive firms. More productive firms benefit more from horizontal spillovers.

We study a second obvious characteristic in which firms differ: their export status which is not independent from productivity since only more productive firms start exporting to foreign market. We expected the export status to have an effect for two reasons. First, exporters are more productive and, second, they are used to interact with foreign firms. However both the fixed effects regression and the quantile regressions revealed no larger spillovers for exporters than for non-exporting domestic firms.

We argue that several theories have been put forward to motivate different effects for heterogeneous firms. We find that the most productive firms gain the most, while the least productive are actually negatively affected by proximity to foreign firms. This supports the idea of an absorptive capacity necessary to reap positive spillover effects. The role of peer pressure on innovative activities of most productive firms is also supported. Convergence of the *least* productive firms, in contrast, does not receive support by our data.

Overall, we find that heterogeneity in terms of productivity affects domestically owned firms' capacity to absorb knowledge and achieve higher productivity.

With respect to our policy related motivation, our findings suggest that FDI may be beneficial for the economy but not for all firms. Results reveal that FDI will only improve the performance of firms that have already achieved a certain level of productivity. Thus, state support to new FDI shall be encouraged if it strengthens supplier links with already productive firms. Further, FDI into less developed regions and industries are likely to have no or even a negative impact on most firms.

7. APPENDIX

7.1. Data source

Description of variables are presented in table 6.

Table 6 – Description of variables

Variable	Details	Source
Output	Net sales by the firm, deflated by sectoral PPI deflators	APEH:income statements
Capital	Fixed assets capital generated and corrected by the perpetual inventory method, following suggestions in Katay and Wolf (2004, 2006)	APEH: income statements
PPI	Producer price deflator, sectoral level	KSH
Ownership	Foreign-owned firms: at least 10% of equity capital is owned by non-residents. (NB. Distribution of the status is bimodal, and results are insensitive to the threshold.)	APEH:balance sheets
Private share	Share of equity capital owned privately (i.e. non-state and non-municipal owners	APEH: balance sheets
Export status	Exporter firm is defined if net export sales reached at least 5% of total net sales. (NB. Distribution of the status is bimodal, and results are insensitive to the threshold.)	APEH:income statements
Investments	Change in fixed assets, reduced by a sector specific depreciation rate calculated from the data, deflated by investment input prices. (NB. Results robust to flat depreciation rate)	APEH: income statements
Investment price deflator	Estimated by authors based on 80% machinery and 20% property price deflators	KSH, authors
Depreciation rate	Directly is estimated from the APEH data. To see robustness of the APEH data, an average of 20% was used, without sizeable impact	authors calc.
Labor	Average annual employment in the given year	APEH:income statements
Materials	All materials, calculated following Katay-Wolf (2006) who advised on how to take care of changes in the accounting law in 2001.	APEH:income statements

Note that one may consider various other variables for the productivity estimation, such as using labor productivity instead of TFP. However, a meta analysis of Diebel and Wooster (2006) suggests that there is no great difference in terms of results, with TFP being the hardest to find significance with. Regarding the measurement of the foreign share, employment as a weight is more likely to yield higher impact than output which is used here.

7.2. Summary Statistics

Table 7 – Summary statistics of variables. Domestically-owned firms only

	Mean	Std. Dev.
Fixed assets (log)	8.324	1.967
Sales (log)	10.78	1.547
Materials (log)	9.468	1.579
Employment (log)	2.848	1.242
Domestic Sales (log)	10.80	1.562
Export Sales (log)	9.660	2.357
Export share	0.114	0.249
Exporter status (dum)	0.253	0.435
Horizontal Linkage	0.330	0.224
Backward Linkage	0.145	0.088
Forward Linkage	0.260	0.242
$R\&D$ Linkage	0.119	0.117
Wholesale linkage	0.262	0.192
Herfindahl index	0.137	0.152
Private share	0.974	0.149
TFP (log)	1.815	0.598

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