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How does FDI inflow affect productivity of domestic firms? The role of horizontal and vertical spillovers, absorptive capacity and competition

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Abstract

This paper examines the existence of externalities associated with FDI in a host country by exploiting firm-level panel data covering the Polish corporate sector. The main findings are as follows: Local firms benefit from foreign presence in the same industry and in downstream industries. Absorptive capacity of domestic firms is highly relevant to the size of spillovers. Competitive pressure facilitates backward spillovers, while market power increases the extent of forward spillovers. Host country equity participation in foreign firms is consistent with higher unconditional productivity spillovers to domestic firms.

JEL classification: F23, O33

Keywords: foreign direct investment, spillovers, firm-level data

Introduction

Foreign direct investment is believed to bring positive spillovers to domestic firms in the recipient country. The idea is that the presence of multinational corporations, which are among the most technologically advanced firms, can facilitate the transfer of technological and business know-how. This transfer may then spread over the entire economy leading to productivity gains in domestic firms (see e.g. Romer (1993)).

This kind of considerations has motivated authorities in many countries to ease restrictions on direct foreign investment and even to offer foreign investors more favourable conditions than those granted to domestic firms.[1] In Central European countries undergoing transition from centrally planned to market economies, governments not only lifted most of restrictions on foreign presence, but made attracting foreign investors one of the key elements of their economic policy. In order to win the race for most prestigious projects in the region, Central European countries often offered generous tax incentives and subsidies, each time trying to overbid rival countries.[2]

At the same time, empirical studies aimed at measuring the size of spillovers from FDI in developing and transition economies have yielded mixed results, leading some of the researchers to a conclusion that the search for universal relationship may be futile (see e.g. Lipsey and Sjöholm (2005)). Indeed, it seems plausible that the diverse results may be attributed to differences in the countries' ability to benefit from foreign investment, reflecting varying levels of absorptive capacity, market structure or economic policies.

The aim of this paper is to add to the understanding of externalities associated with FDI in a host transition country by exploiting unique and extensive firm-level panel data covering the Polish corporate sector. Contrary to most of the previous related studies, our data set includes not only manufacturing companies, but also covers services. This should be considered important, since the share of services in GDP or employment is usually several times larger than that of manufacturing. Moreover, in many countries services already account for a larger part of foreign direct investment than manufacturing (see UNCTAD (2004)).

We look for possible spillovers to domestic firms not only from foreign-owned firms operating in the same industry (horizontal spillovers), but also try to find evidence for externalities arising from backward or forward trade linkages between foreign and domestic firms. Moreover, we examine whether absorptive capacity of domestic enterprises and competitive pressure facilitate spillovers from foreign direct investment. In order to make sure that our results do not rely heavily on particular assumptions underlying our identification strategy, we supplement the analysis with a battery of robustness checks.

The rest of this paper is organised as follows. Section 1 summarizes the theoretical and empirical arguments on spillovers from foreign direct investment. Section 2 describes the estimation strategy. The data set on Polish enterprises is described in section 3. Section 4 presents the results. Finally, the concluding remarks are detailed in section 5.

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[1] See e.g. Girma, Greenaway and Wakelin (2001), Hanson (2001), Haskel, Pereira and Slaughter (2002), Neven and Siotis (1993), UNCTAD (1996 and 2000).

[2] For an extensive study on competition for foreign direct investment between Central European countries, see Sedmihradsky and Klazar (2001). For studies looking at competition between US states, see Coughlin, Terza and Arromdee (1991) or Hines (1996). Competition between EU countries was studied by Neven and Siotis (1993).

1

Theoretical background and related research

It has been widely recognized that multinational corporations are among the most technologically advanced firms, investing more of their resources in research and development (R&D) than purely domestic firms (see e.g. Griffith (1999)). It is estimated that a substantial part of the world's R&D activities is carried out by companies operating in more than one country (see e.g. Borensztein, De Gregorio and Lee (1998)), which translates into higher rates of innovation and patenting compared to firms not operating abroad (see e.g. Criscuolo, Haskel and Slaughter (2005)). Technological superiority, better managerial practices and the ability to exploit economies of scale makes it possible for multinationals investing in a previously unexplored country to compete with local firms even though the latter are usually more familiar with local consumer preferences and business practices (see Blomström and Sjöholm (1999)).[3]

If multinationals possess knowledge-based intangible assets that are not generally available in the host country, then it is reasonable to assume that at least some of their technological superiority may spill over to domestic firms via channels other than market transactions, such as purchases of patents, licences etc. According to the theoretical literature, there are several well-known mechanisms through which spillovers may occur (see e.g. Görg and Greenaway (2003), Blomström and Kokko (2003)).

First, domestic enterprises may upgrade their technology by imitating foreign companies' products and processes (via reverse engineering) or managerial and organisational innovations (see e.g. Wang and Blomström (1992)). Secondly, knowledge can leak out by employment turnover, i.e. workers trained by a multinational company or having access to its crucial intangible assets may move to existing domestic firms or start their own businesses (see e.g. Fosfuri, Motta and Rønde (2001)). Thirdly, direct competition from foreign companies may force the domestic companies to reduce inefficiencies, leading to productivity gains (see e.g. Glass and Saggi (2002)).

The mechanisms described above typically refer to spillovers from foreign to domestic firms operating in the same industry. Clearly, the former have a strong incentive to prevent any leakages of their superior technology to direct competitors. In particular, they may try to protect some of their intangible assets with patents or offer their workers (especially managers) relatively high wages to prevent spillovers through employment turnover. Another reason why horizontal (i.e. intra-industry) spillovers may not occur is that foreign and domestic firms may not compete in the same market, for instance multinationals may specialize in the upper market segment or produce for exports, while domestic firms may focus on the local market only. Similarly, as argued by Kokko (1994), foreign companies may operate in "enclaves", where neither products nor technologies have much in common with those of local firms.

[3] For theoretical models relying on technological superiority of multinational corporations, see Markusen (1995), Carr, Markusen and Maskus (2001), Helpman, Melitz and Yeaple (2004).

These considerations led some of the researchers to a conclusion that the existence of horizontal spillovers is very limited. In contrast, they argue that vertical (i.e. inter-industry) spillovers are far more likely, since multinationals may have incentives to provide technology to their suppliers (backward spillovers), and probably also to their customers (forward spillovers).[4]

In the case of backward spillovers, foreign companies may be interested in increasing the quality of the intermediate inputs they purchase from domestic suppliers. As pointed out by Blalock and Gertler (2005a), foreign companies may want to transfer technology not to a single supplier, since it could use its monopoly power to capture all of the rents from its increased productivity, but to multiple suppliers and potential entrants.[5] Similarly in the case of forward spillovers, a foreign company may increase demand for its products by providing assistance to domestic customers and showing them how to use these products effectively.

Even if there is no direct knowledge transfer to from foreign to domestic firms, vertical spillovers may still be present (see Smarzynska-Javorcik (2004)). First, multinationals usually set higher requirements regarding product quality and on-time delivery, which may induce domestic suppliers to increase their productivity. Secondly, the entry of a foreign company increases demand for intermediate products, which allows local suppliers to exploit economies of scale (see e.g. Rivera-Batiz and Rivera-Batiz (1990)) or leads to the entry of new firms and reduction in the cost of production (see Markusen and Venables (1999)). Thirdly, similarly to the models of international technology diffusion via trade (see e.g. Coe and Helpman (1995)), better availability of intermediate goods with high technology content produced by foreign companies may increase productivity of domestic firms operating in downstream industries. Finally, mechanisms typically related to horizontal spillovers (imitation, employment turnover etc.), although less likely in the case of vertical spillovers, may occur as well.

It has to be noted that foreign capital involvement may be beneficial for a host country even in the absence of spillovers. In the case of Central and Eastern European economies undergoing transition, foreign direct investment was expected to play an important role in the process of restructuring the formerly state-owned companies (see Blanchard (1997), EBRD (1994)).

Spillovers from foreign presence to domestic firms do not have to be positive. At least in the short run, productivity of local companies operating in the same industry as a foreign entrant may decrease through the so-called market stealing (or competition) effect. More precisely, multinationals may exploit their technological (and cost) advantage and attract demand away from local firms, forcing them to reduce production and move up their average cost curve (see Aitken and Harrison (1999)). Moreover, negative side-effects from the presence of foreign establishments may arise with their headhunting for most qualified employees, eroding the stock of human capital in the domestic enterprises. Negative vertical spillovers are possible as well. Having acquired a domestic company, a multinational corporation may decide to source intermediate inputs abroad, breaking the existing supply chains and forcing the former domestic suppliers to cut production.

[4] Naturally, spillovers take place only if the foreign company does not fully internalise the resulting productivity increase in its suppliers or customers through charges for their services etc.

[5] It should be noted that by transferring technology backwards, the foreign company inadvertently aids its competitors as long as it cannot prevent its suppliers to sell their products to other companies. However, Pack and Saggi (2001) show that if the competition is not too great, it is still beneficial for the foreign company to transfer technology to many suppliers. Moreover, under plausible assumptions, the benefits from backward spillovers should accrue widely to all sectors and consumers, inducing a Pareto improvement in welfare.

The existing empirical literature on the extent of productivity spillovers from foreign investment in developing or transition countries can be grouped in three categories. First, there are macro-level studies, using the cross-country growth regressions framework (see e.g. Borensztein, De Gregorio and Lee (1998), Carkovic and Levine (2005)). Second, there are cross-industry studies (see e.g. Bloström (1986), Kokko (1994), Kugler (2005)). The results obtained from these two approaches have been subject to criticism, since they may not fully control for possible simultaneity bias. These problems can be dealt with in papers employing panel micro data, which is also the approach followed in this paper.[6]

Firm-level panel data studies for developing or transition economies focused mainly on horizontal spillovers, usually finding insignificant or even negative spillovers from foreign presence (see Görg and Greenaway (2003) for a meta analysis). So far, empirical research on vertical spillovers in transition countries has been relatively scarce. Notable exceptions are Schoors, Van der Tol (2002) who find positive backward spillovers and negative forward spillovers in Hungarian companies, Smarzynska-Javorcik (2004) who finds evidence for positive backward spillovers in firms from Lithuania, and Yudaeva, Kozlov, Melentieva and Ponomareva (2003) whose results imply strong negative vertical spillovers to Russian firms.

In view of the mixed results obtained by numerous studies, there seems to be consensus in the literature that there may be no universal relationship between foreign direct investment and productivity of domestic firms. In other words, countries and firms within countries may differ in their ability to benefit from the presence of foreign-owned firms and their superior technology (Lipsey and Sjöholm (2005)). Indeed, there is ample evidence suggesting that country or firm specific characteristics may determine the extent to which the host country benefits from foreign investment.

In particular, whether domestic firms are able to learn from foreign firms or not may crucially depend on their absorptive capacity. For instance, in their cross-country study Borensztein, De Gregorio and Lee (1998) argue that foreign investment has a positive growth effect only when the host country has a minimum threshold stock of human capital. Evidence for the role of absorptive capacity (usually proxied by R&D activities of domestic firms) in the context of horizontal spillovers has also been found in micro-level panel data studies for transition or developing economies (see e.g. Kinoshita (2001), Blalock and Gertler (2005b), Chudnovsky et al. (2003), Konings (2001), Sinani and Meyer (2002)). The author of this paper is aware of only one study considering the impact of absorptive capacity on the extent of vertical spillovers in transition economies, which is Schoors and Van der Tol (2002).

Also, it is reasonable to expect that domestic firms operating under strong competitive pressure are better prepared to benefit from foreign presence than others. Empirical evidence supporting this thesis can be found for instance in Sjöholm (1999) or Sinani and Meyer (2002). Among many other factors that might influence the extent of spillovers, the impact of which we do not examine in this paper, one can also name sufficiently developed financial markets, trade openness or the quality of institutions.

[6] Another strand of literature on spillovers from foreign direct investment is descriptive material, such as case studies, surveys and interviews (see Moran (2001), Javorcik and Spatareanu (2005), Blalock and Gertler (2005a)). While such studies may fail to reveal the quantitative impact of foreign presence, they provide interesting information about the various channels through which spillovers may occur.

2

Empirical model

2

Similarly to some earlier studies on the topic, our strategy to examine the existence of horizontal and vertical spillovers from foreign direct investment is to estimate a firm-level production function augmented by the terms measuring foreign presence in the same sector and in upstream or downstream industries. Similarly to Haskel et al. (2002) and Smarzynska-Javorcik (2004), we estimate the production function in first differences. Some other related papers (including Aitken and Harrison (1999), Blalock and Gertler (2005a, 2005b)) estimated the production function in levels. This approach, however, is more vulnerable to the problem of omitted unobserved variables. As pointed out by Haskel et al. (2002), first differencing removes any firm or region specific fixed factors that may be correlated with both firm productivity and foreign presence. Indeed, it seems plausible that foreign investors are more likely to take over or cooperate with most productive firms and locate their business in regions with high-quality infrastructure. There may also exist firm or time specific unobservables affecting not only firms' productivity levels, but also their growth potential. We control for such kinds of effects by including time and firm specific dummies to our first-differenced equation. Specifically, our baseline firm-level production function can be written in a log-linear form as (lower case letters denote natural logarithms):

$$\Delta y_{it} = \beta_1 \Delta m_{it} + \beta_2 \Delta l_{it} + \beta_3 \Delta k_{it} + \beta_4 \Delta HZ_{jt} + \beta_5 \Delta BW_{jt} + \beta_6 \Delta FW_{jt} + \varepsilon_i + \varepsilon_t + \varepsilon_{it} \quad (1)$$

Y_{it} is the value of gross output for firm *i* at time *t*, deflated by the price index for the relevant two, three or four-digit industry (depending on data availability). M_{it} stands for intermediate inputs, deflated by price indexes constructed for each two-digit sector using the input-output table (available only at a two-digit level) and the relevant two-digit gross output and import deflators. Labour input, L_{it}, is measured as the number of workers (preferred statistics, such as full-time equivalent or total hours worked, are not available). Capital input, K_{it}, is calculated as the average book value of fixed assets (assuming linear change in the stock during the year), deflated by the capital goods deflator for the appropriate two-digit sector.

For each two-digit industry *j*, HZ_{jt}, BW_{jt} and FW_{jt} measure the extent of foreign presence in the same industry, upstream sector and downstream sector, respectively. HZ_{jt}, designed to capture horizontal spillovers from foreign presence, is defined as the share of an industry's output produced by foreign-owned firms. Specifically,

$$HZ_{jt} = \frac{\sum_{i \in j} Y_{it} \cdot F_{it}}{\sum_{i \in j} Y_{it}}$$

where F_{it} is a dummy variable equal to one if the firm is foreign-owned (i.e. more than a half of its equity is owned by non-residents) and zero otherwise.[7]

[7] Our dataset does not allow us to define F_{it} as a share of foreign equity in a company's total equity. However, there is evidence that multinationals may be reluctant to transfer new and complex technologies to their

BW_{jt} serves as a proxy for backward linkages to foreign-owned firms. On the assumption that a firm's share of a sector's demand for a particular input is equal to its output share, BW_{jt} measures the proportion of an industry's output of intermediate goods (consumed in the country) supplied to foreign-owned firms. Formally,

$$BW_{jt} = \sum_{k} a_{jk} HZ_{kt}$$

where a_{jk} is the proportion of sector *j* output (serving as intermediate inputs elsewhere in the country) supplied to sector *k*, taken from the input-output matrix.

By analogy, FW_{jt} captures the extent of foreign presence in downstream industries and is defined as the proportion of a sector's intermediate consumption supplied by foreign-owned firms:

$$FW_{jt} = \sum_{k} a_{kj} HZ_{kt}$$

A substantial part of foreign direct investment inflow to Poland was connected with privatisation of state-owned companies during the transformation period. There is anecdotal evidence that foreign investors have tended to take over companies with high growth potential rather than ailing ones.[8] As pointed out by Smarzynska-Javorcik (2004), failing to take this issue into account might produce biased results. Therefore, we estimate all our main equations on a sample of domestic firms only (i.e. for which $F_{it} = 0$). We interpret positive (negative) estimated coefficients on variables HZ_{jt}, BW_{jt} and FW_{jt} as evidence consistent with positive (negative) productivity spillovers to domestic firms from foreign presence in the same industry or in downstream and upstream sectors. We refer to the three effects as horizontal, backward and forward spillovers.

Additionally, we expand our baseline model to examine whether absorptive capacity of domestic enterprises and competitive pressure facilitate spillovers from foreign direct investment. We do so by interacting the three variables capturing foreign presence with two measures of firm-level innovation intensity (RDQ_{it} and INQ_{it}) and Herfindahl-Hirschmann index of market concentration for the relevant two-digit industry (HHR_{it}).

More specifically, we define RDQ_{it} as the share of net R&D expenditures in a firm's sales. The difference between RDQ_{it} and INQ_{it} is that the latter assumes a broader definition of innovation expenditures, i.e. it includes net increase in all intangible assets other than the firm value (R&D, purchase of patents, licences, software etc.). Our specification follows closely that adopted by Kinoshita (2001), i.e. we let one of the two innovation variables enter both independently and in interaction with either of the three FDI variables defined above. A positive coefficient on either of the interaction terms can be interpreted as evidence for the so-called second face of innovation expenditures (or in particular R&D), i.e. enhancement of capacity for absorbing foreign knowledge from foreign direct investment.[9] We follow a similar estimation strategy with the market concentration index.

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subsidiaries which are not fully or majority owned. See Mansfield and Romero (1980) or Kogut and Zander (1993).

[8] This anecdotal evidence seems to be confirmed in the case of another post-socialist Central European economy, the Czech Republic. See Djankov and Hoekman (2000), Evenett and Voicu (2001).

[9] The first face of R&D is pure innovation (see Cohen and Levinthal (1989)). See also Griffith et al. (2001) who try to detect empirically the second face of R&D as enhancement of capacity for technology transfer, without referring to any particular channel through which it might operate (e.g. FDI or foreign trade).

3

Data

3

The main data source are yearly balance-sheet and profit-and-loss reports of non-financial enterprises (F-02 forms) collected by Poland's Central Statistical Office. The reporting duty applies to all enterprises employing at least 10 workers. The firms in the dataset are non-identifiable. However, each of them can be characterized by the kind of economic activity (according to the Polish Classification of Activities, which is compatible with NACE), ownership status (e.g. public, private, foreign), the number of employees etc.[10] The dataset constitutes an unbalanced panel, spanning over the period 1996-2003. The number of establishments per year varies from 25,171 in 1998 to 14,878 in 2002, adding up to 147,479 observations for the whole sample. Due to missing values and transformations required by our estimation strategy (including first-differencing), the sample is reduced to 105,335 observations. There are 10,644 observations for foreign-owned firms in our dataset, so when we run regressions on a subset of domestic firms only, the sample is further truncated to 94,691 observations.

Table 1. Summary statistics

Variables	Full sample		Domestic firms only	
	Mean	Std. Dev.	Mean	Std. Dev.
Q^a	25,453	143,597	20,347	132,288
M^a	14,693	87,968	11,693	78,764
L	223	1127	211	1163
K^a	14,642	112,599	13,552	114,785
HZ	0.226	0.192	0.211	0.182
BW	0.219	0.078	0.217	0.078
FW	0.225	0.060	0.223	0.059
RDQ	0.0000076	0.0134435	0.0000141	0.0135752
INQ	0.0029366	0.6122871	0.0032684	0.6441516
HHR	0.0251	0.0485	0.0249	0.0489

[a] volumes in constant 1996 prices.

The firm-level dataset is supplemented by industry-level statistics, including price indexes and input-output tables (available only for 2000 at a two-digit level of aggregation[11]). All of them come from official publications of Poland's CSO.

The summary statistics for the main variables used in the econometric analysis are presented in Table 1.

[10] See Rogowski and Socha (2005) for a more extensive description of firm-level datasets available for Poland.

[11] Ideally, we would prefer to use different input-output tables for each year, since the inter-sector relationships they capture may change over time (although sizable changes are rather unlikely). Unfortunately, input-output tables for Poland are available only at five-year intervals. Moreover, since imports cannot be separated from the flow of intermediate inputs for the 1995 matrix, in all our calculations we use the matrix for 2000.

4

Estimation results

We estimate a number of equations similar to (1), each time regressing change in (log) gross output on change in (log) inputs and various measures of foreign presence, innovative activity and competitive pressure defined in section 2 (including interactions). Since our specification can be viewed as an augmented production function, coefficient estimates on the non-input explanatory variables capture their contribution to growth in multi-factor productivity (MFP).

We estimate our model using a firm-level (or industry-level) fixed-effect estimator, with a full set of time dummies.[12] Since one of the key questions this paper seeks to answer is whether productivity of domestic firms in Poland has been influenced in a statistically significant way by the various factors set out in section 2, validity of the inference we may want to draw relies heavily on obtaining unbiased standard errors for the estimated coefficients.

One of the well-known problems encountered while working with non-homogenous observations is possible heteroskedasticity. We deal with this issue by using robust estimates of the variance-covariance matrix developed by White (1980).

Yet there is another problem, which is connected with the way we define some of our regressors. More specifically, we work with firm-level data, but some of our explanatory variables do not have a firm-dimension. In particular, this concerns the three proxies for foreign presence, but also the index of market concentration, all of which are defined at a two-digit industry level. As it was shown by Moulton (1990), merging micro-data with aggregated variables may lead to a serious downward bias of OLS standard errors. The magnitude of the bias has been analysed by Kloek (1981), Scott and Holt (1982), Greenwald (1983) and Moulton (1986), who found that it increases with the average group size, the intra-group correlation of the disturbances and the inter-group correlations of the regressors. Obviously, for an aggregate regressor, which is fixed within the group (in our case within the two-digit industry), the intra-group correlation of the regressor is one. Moulton (1990) demonstrates that this type of bias may result in spurious finding of statistical significance for the aggregate variable of interest. We address this issue by correcting standard errors for clustering for each two-digit industry in each year (in other words, we allow for correlation between the observations for the same industry in a given year).

4.1. Horizontal and vertical spillovers

Table 2 reports the results for the baseline variations of equation (1), i.e. we try to assess the role of horizontal and vertical spillovers in productivity growth of domestic enterprises. We start by running the regression on a full sample of firms, adding a full set of two-digit industry dummies and controlling for the possible differences between domestic and foreign firms by

[12] A Hausman test run on preliminary regressions clearly rejected random effect models in favour of fixed effect models.

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including a foreign-ownership dummy (F_{it}). We find positive and significant coefficients on proxies for horizontal and backward spillovers, whereas the effect of forward spillovers is not statistically different from zero. Not surprisingly, the coefficient on foreign-ownership is positive and statistically significant, suggesting that firms with at least 50% foreign equity participation record on average higher productivity gains than those which are mostly domestically-owned.

We repeat the estimations replacing industry dummies with firm dummies. The results for the three types of spillover effects are unaffected: only horizontal and backward spillovers are significant. Since now most of firm-specific fixed characteristics, including possible differences resulting from foreign capital participation, are captured by firm dummies, the foreign ownership dummy loses significance (but is still positive). Comparing the two specifications, the Hausman test clearly favours the one with firm dummies.

It may be argued that foreign-ownership dummy is insufficient to control for differences between foreign and domestic enterprises, so we repeat our estimations for the sample of domestic firms only. The precision of estimates has slightly fallen, but the findings remained broadly unchanged, both in terms of possible extent of productivity spillover effects and conclusions from the Hausman test. To be on the safe side, in all regressions that follow we stick to the specification with firm dummies and a subset of domestic firms.

Table 2. Horizontal and vertical spillovers from foreign presence to domestic firms

Regressors	Coefficients (standard errors)				
	1	2	3	4	5
Δm_{it}	0.630*** (0.011)	0.604*** (0.009)	0.638*** (0.012)	0.614*** (0.010)	0.614*** (0.010)
Δl_{it}	0.142*** (0.007)	0.136*** (0.007)	0.143*** (0.007)	0.136*** (0.008)	0.136*** (0.008)
Δk_{it}	0.075*** (0.005)	0.072*** (0.006)	0.071*** (0.005)	0.068*** (0.007)	0.069*** (0.007)
ΔHZ_{jt}	0.035* (0.018)	0.039* (0.020)	0.034* (0.019)	0.041* (0.021)	0.040* (0.021)
ΔBW_{jt}	0.211** (0.091)	0.208** (0.099)	0.234** (0.099)	0.214** (0.107)	0.208** (0.106)
ΔFW_{jt}	0.057 (0.129)	-0.089 (0.137)	0.116 (0.136)	-0.051 (0.141)	
Foreign ownership (F_{it})	0.022*** (0.004)	0.008 (0.011)			
Domestic firms only	No	No	Yes	Yes	Yes
Firm dummies	No	Yes	No	Yes	Yes
Industry dummies	Yes	No	Yes	No	No
Year dummies	Yes	Yes	Yes	Yes	Yes
Number of observations	105 335	105 335	94 691	94 691	94 691
Autocorrelation[a]	1.60	2.14	2.15	1.60	2.15
Hausman test[b]	89.91	–	37.31	–	–
R^2 (adjusted)	0.545	0.541	0.546	0.541	0.541

***, ** and * denote significance at 1%, 5% and 10%, respectively.
[a] First-order Durbin-Watson statistics.
[b] In column 1, tests for equality of coefficients between specifications in columns 1 and 2; in column 3, tests for equality of coefficients between specifications in columns 3 and 4.

Finally, we rerun the last regression dropping the insignificant forward spillover term. We still find both horizontal and backward spillover effects significant. Summarizing, our findings suggest that there is some learning from both direct foreign competitors and foreign companies operating in the downstream sectors (e.g. through the supply chains). Both effects are economically meaningful, however the size of the latter effect seems to be substantially stronger. According to our estimates, an increase of 1 percentage point in foreign presence in downstream sectors leads to an increase in productivity (or output) by about 0.2%, whereas a similar rise for the same sector is associated with a productivity gain of 0.04%.

Our results indicating positive backward spillovers from foreign direct investment are consistent with the findings in Schoors and Van der Tol (2002), Smarzynska-Javorcik (2004) and Blalock and Gertler (2005a). On the contrary, most studies using panel data for the European transition economies find either insignificant or even negative spillovers from foreign presence in the same industry (see e.g. Bosco (2001), Djankov and Hoekman (2000), Kinoshita (2001), Konings (2001), Smarzynska-Javorcik (2004), Zukowska-Gagelman (2002)). However, there are two problems with comparing our findings on horizontal spillovers with these previous studies. First, they refer to the earlier stage of transition – all of the studies mentioned above that find negative effects to domestic firms from FDI in the same industry include observations not going beyond 1997. Secondly, attention of other studies is usually restricted to manufacturing establishments, whereas our data set covers also other non-financial enterprises. We come back to this issue in section 4.4, where we reestimate our preferred specifications on a subsample of manufacturing firms.

4.2. Absorptive capacity

We next examine whether firms with greater absorptive capacity benefit more from foreign presence than others. We start by playing around with the first measure of a firm‘s innovative effort, *RDQ*, which can be approximately interpreted as net R&D intensity. The results are reported in Table 3.

First we add net R&D intensity as an explanatory variable to regression including all three measures of foreign presence. Consistently with the findings in Kolasa (2005) for Poland’s manufacturing industries, the R&D intensity term enters the equation positively and significantly. Since we run the regression at a firm level, we can broadly interpret the coefficient on *RDQ* as the private (excess[13]) rate of return on R&D investment.[14] The point estimate of 32,4% is similar to the result obtained by Goto and Suzuki (1989) for Japan, but significantly higher than that reported by Kinoshita (2001) for the Czech Republic. All in all, our estimate of the private rate of return for Polish firms should be considered as relatively high, since it is close to the social rate of return obtained for other countries (see e.g. Hall (1996), Griliches and Lichtenberg (1984), Scherer (1982)).[15]

[13] Since we cannot distinguish inputs used to generate R&D (in particular, R&D capital and R&D personnel) from other forms of inputs, the rate of return we obtain in our regression is the excess rate of return the R&D inputs earn over that contributed by other forms of inputs (see Schankerman (1981)).

[14] As pointed out by Jones and Williams (1998), measurement issues leading to biased estimates of the rate of return to R&D are particularly acute in regressions with firm-level data. Therefore one should be very careful while interpreting our point estimates as a reliable approximation to the true rate of return to R&D in Poland.

[15] Similarly to Jones and Williams (1998), we refer to the estimates of the private (social) rate of return to R&D as to those obtained from firm-level (industry-level) data. The social rate of return should be higher than the private rate of return as long as there are interfirm positive spillovers from R&D.

Next we augment the above specification with three interactions, defined as *RDQ* multiplied by each of the three measures of foreign presence. In such a regression, all three interactions as well as *RDQ* are statistically insignificant, suggesting that we might have problems with collinearity. Indeed, all three interactions are highly correlated with *RDQ*, which should not be surprising given that the latter is relatively more volatile and measured at a firm level, whereas all our measures of foreign presence have only an industry dimension. As a result, most of the variation in the interactions comes from *RDQ*, which leads to collinearity in our specification.

In order to deal with this problem we follow the general-to-specific strategy and eliminate stepwise the least significant coefficients. We come up with two alternative specifications, in which the R&D-related variables enter in a statistically significant way.[16] The first one includes *RDQ* and its interaction with backward spillovers, indicating that domestic firms involved in research and development activities benefit more from foreign presence in downstream industries than others. Our results may also suggest that foreign companies build their local supply chains by transferring technology to the domestic firms with sufficient absorptive capacity.

In the second specification we drop the *RDQ* variable adding instead its interaction with forward linkages. We find both interactions of *RDQ* (i.e. with backward and forward spillovers) statistically significant. A positive coefficient on forward spillovers interacted with *RDQ* may indicate that domestic firms with higher absorptive capacity can exploit knowledge embodied in intermediate goods produced by multinationals better than others. Both forward and backward spillovers interactions in the last specification are economically meaningful. The average value of *RDQ* for those companies recording positive changes in their net R&D stock is about 0.015. Therefore, the productivity gain associated with an increase in foreign presence in downstream (upstream) industries of 1 percentage point is by 0.2 (0.1) percentage points larger for a company expanding its absorptive capacity (measured by R&D stock) compared to a firm keeping it unchanged.

Contrary to some earlier studies for other transition or developing countries, we do not find evidence for the role of R&D in facilitating positive horizontal spillovers in Poland's corporate sector. One of possible explanations could be that positive correlation between productivity of domestic firms and foreign presence in the same industry does not necessarily result from leakages of superior technology possessed by foreign firms, but rather reflects imitation of their (organizational) practices by local companies or just elimination of inefficiencies forced by increased competition. Another explanation we find plausible is that the technological gap between foreign and domestic firms in the upper market segment (where R&D is crucial) is too large for the latter to upgrade their technology basing only on their own research effort.

[16] Whenever we report a final specification including only significant regressors, the Wald test supported the validity of all zero-restrictions implicitly imposed.

Table 3. Absorptive capacity and spillovers from foreign presence to domestic firms

Regressors	Coefficients (standard errors)			
	1	2	3	4
Δm_{it}	0.614*** (0.010)	0.613*** (0.010)	0.613*** (0.010)	0.613*** (0.010)
Δl_{it}	0.136*** (0.008)	0.136*** (0.008)	0.136*** (0.008)	0.136*** (0.008)
Δk_{it}	0.069*** (0.007)	0.069*** (0.007)	0.069*** (0.007)	0.069*** (0.007)
ΔHZ_{jt}	0.041* (0.021)	0.042* (0.021)	0.040* (0.021)	0.040* (0.021)
ΔBW_{jt}	0.216** (0.107)	0.212** (0.107)	0.208* (0.106)	0.208** (0.106)
ΔFW_{jt}	-0.052 (0.142)	-0.050 (0.142)		
RDQ_{it}	0.324*** (0.101)	0.152 (0.267)	0.215*** (0.049)	
$RDQ_{it} \cdot \Delta HZ_{jt}$		-2.784 (12.714)		
$RDQ_{it} \cdot \Delta BW_{jt}$		4.563 (10.554)	10.106*** (2.384)	13.523*** (2.661)
$RDQ_{it} \cdot \Delta FW_{jt}$		13.108 (12.681)		7.070*** (2.864)
Domestic firms only	Yes	Yes	Yes	Yes
Firm dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Number of observations	94 691	94 691	94 691	94 691
Autocorrelation[a]	2.15	2.15	2.15	2.15
R^2 (adjusted)	0.541	0.541	0.541	0.541

***, ** and * denote significance at 1%, 5% and 10%, respectively.
[a] First-order Durbin-Watson statistics.

We repeat our analysis using the second (broader) measure of innovation effort, *INQ*, which includes not only net R&D expenditures, but net increase in all intangible assets other than the firm value. The results are reported in Table 4.

We find a similar pattern to that obtained for *RDQ*. When added to the regression that includes all three measures of foreign presence, *INQ* is found highly significant, confirming again the findings in Kolasa (2005). Supplementing the regression with three interactions, defined analogously as before, yields insignificant coefficients, pointing to collinearity problems similar to those encountered while using *RDQ*. Following a general-to-specific strategy we arrive at only one specification, in which both *INQ* and its interaction with a proxy for horizontal spillovers are found highly significant. This may suggest that, contrary to what was found by Sinani and Meyer (2002), investing in intangible assets helps to increase the benefits reaped by domestic firms from foreign presence in the same industry.

Table 4. Absorptive capacity and spillovers from foreign presence to domestic firms: a broader definition of innovation expenditures

Regressors	Coefficients (standard errors[a])		
	1	2	3
Δm_{it}	0.612*** (0.010)	0.612*** (0.010)	0.612*** (0.010)
Δl_{it}	0.136*** (0.008)	0.136*** (0.008)	0.136*** (0.008)
Δk_{it}	0.069*** (0.007)	0.068*** (0.007)	0.068*** (0.007)
ΔHZ_{jt}	0.041* (0.022)	0.041* (0.021)	0.039* (0.021)
ΔBW_{jt}	0.213** (0.107)	0.206* (0.106)	0.199* (0.105)
ΔFW_{jt}	-0.052 (0.142)	-0.061 (0.143)	
INQ_{it}	0.024*** (0.001)	0.037 (0.049)	0.035*** (0.006)
$INQ_{it} \cdot \Delta HZ_{jt}$		1.014 (0.717)	1.059*** (0.547)
$INQ_{it} \cdot \Delta BW_{jt}$		1.151 (1.830)	
$INQ_{it} \cdot \Delta FW_{jt}$		-1.048 (1.009)	
Domestic firms only	Yes	Yes	Yes
Firm dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
Number of observations	94 691	94 691	94 691
Autocorrelation[a]	2.15	2.15	2.15
R^2 (adjusted)	0.542	0.542	0.542

***, ** and * denote significance at 1%, 5% and 10%, respectively.
[a] First-order Durbin-Watson statistics.

Remember that we did not find any relationship between firms' R&D effort and the extent of horizontal spillovers. We interpret these two results as consistent with the hypothesis that the technological gap between domestic firms and their competitors from abroad is too large for the former to exploit additional spillovers relying on their own-R&D-based absorptive capacity only. However, they can increase the benefits they reap from foreign presence by upgrading their stock of knowledge reaching out for (and adopting) the fruit of other firms' innovation effort, which is embodied in available patents, licences, software etc.

4.3. Competition

We next try to examine how competition affects productivity of domestic firms and what role it plays in accounting for the extent of spillovers from foreign presence. The results are reported in Table 5.

First we add Herfindahl-Hirschmann index of market concentration (*HHR*) as an explanatory variable to regression including all three measures of foreign presence. It enters with an expected sign, indicating that the pace of productivity growth is negatively correlated with growing concentration, however, the coefficient is not statistically significant.

Augmenting our specification with interactions, defined as *HHR* multiplied by each of the three measures of foreign presence, shows that higher competition is associated with larger spillovers from foreign presence in downstream industries. The possible interpretation is that domestic firms operating in highly competitive environment are more effective and therefore better prepared to cooperate with foreign clients, which are usually more demanding and high-quality oriented.

Table 5. Competition and spillovers from foreign presence to domestic firms

Regressors	Coefficients (standard errors)		
	1	2	3
Δm_{it}	0.614*** (0.010)	0.614*** (0.010)	0.614*** (0.010)
Δl_{it}	0.136*** (0.008)	0.136*** (0.008)	0.136*** (0.008)
Δk_{it}	0.069*** (0.007)	0.069*** (0.007)	0.069*** (0.007)
ΔHZ_{jt}	0.042* (0.022)	0.056** (0.024)	0.036* (0.021)
ΔBW_{jt}	0.217** (0.107)	0.321** (0.133)	0.320** (0.128)
ΔFW_{jt}	-0.059 (0.142)	-0.192 (0.162)	
HHR_{jt}	-0.081 (0.078)	-0.075 (0.096)	
$HHR_{jt} \cdot \Delta HZ_{jt}$		-0.407 (0.266)	
$HHR_{jt} \cdot \Delta BW_{jt}$		-2.842* (1.533)	-3.136** (1.387)
$HHR_{jt} \cdot \Delta FW_{jt}$		3.035** (1.230)	1.830* (0.957)
Domestic firms only	Yes	Yes	Yes
Firm dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
Number of observations	94 691	94 691	94 691
Autocorrelation[a]	2.15	2.15	2.15
R^2 (adjusted)	0.541	0.541	0.541

***, ** and * denote significance at 1%, 5% and 10%, respectively.
[a] First-order Durbin-Watson statistics.

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On the contrary, higher concentration (and lower competition) seems to be consistent with larger spillovers from foreign presence in upstream sectors. This may suggest that using foreign (and technologically superior) inputs leads to productivity gains, but may require additional costs (e.g. investment, training for the employees, marketing of new products), which can only be covered if the firm has some market power or is able to expand its market share exploiting increasing returns to scale.

Table 6. Results for manufacturing firms

Regressors	Coefficients (standard errors)				
	1	2	3	4	5
Δm_{it}	0.615*** (0.014)	0.615*** (0.014)	0.615*** (0.014)	0.609*** (0.013)	0.615*** (0.014)
Δl_{it}	0.096*** (0.007)	0.096*** (0.007)	0.096*** (0.007)	0.095*** (0.007)	0.096*** (0.007)
Δk_{it}	0.067*** (0.006)	0.068*** (0.006)	0.068*** (0.006)	0.067*** (0.006)	0.067*** (0.006)
ΔHZ_{jt}	0.001 (0.023)	0.000 (0.023)	-0.000 (0.023)	0.002 (0.023)	-0.002 (0.023)
ΔBW_{jt}	0.271*** (0.109)	0.275*** (0.109)	0.275*** (0.109)	0.275*** (0.109)	0.450*** (0.142)
RDQ_{it}		0.355*** (0.046)			
$RDQ_{it} \cdot \Delta BW_{jt}$		4.192** (2.163)	16.437*** (2.994)		
$RDQ_{it} \cdot \Delta FW_{jt}$			10.135*** (2.607)		
INQ_{it}				0.052*** (0.013)	
$INQ_{it} \cdot \Delta HZ_{jt}$				2.638** (1.194)	
HHR_{jt}					-0.406** (0.193)
$HHR_{jt} \cdot \Delta BW_{jt}$					5.145** (2.637)
$HHR_{jt} \cdot \Delta FW_{jt}$					7.122* (3.736)
Domestic firms only	Yes	Yes	Yes	Yes	Yes
Firm dummies	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes
Number of observations	36 384	36 384	36 384	36 384	36 384
Autocorrelation[a]	2.080	2.080	2.080	2.087	2.079
R^2 (adjusted)	0.698	0.699	0.699	0.703	0.699

***, ** and * denote significance at 1%, 5% and 10%, respectively.
[a] First-order Durbin-Watson statistics.

4.4. Removing non-manufacturing firms

In order to facilitate comparisons with some previous studies, we repeat our estimations on a sample of manufacturing enterprises. The main results are summarized in Table 6.

Suppressing our dataset to manufacturing firms leads to qualitatively similar conclusions. The only significant exception is that, similarly to related studies for other countries, we do not find evidence for unconditional horizontal spillovers from foreign direct investment. This may suggest that in the case of manufacturing, the productivity gap between competing foreign and domestic firms is so large that the latter find it hard to absorb possible technology leakages from the former. Another interpretation could be that even if technology transfer exists, it may be offset by the market-stealing effect, i.e. foreign firms possessing sufficiently high technological advantage over domestic firms may draw demand from them, which at least in the short run will lead to a decline in productivity of domestic firms.

4.5. Spillovers from wholly vs. majority-owned foreign firms

Given the possible channels through which spillovers from foreign presence operate, it is reasonable to expect that their extent may depend on whether foreign investors enter the host country by setting up fully-owned subsidiaries or rather by letting the local capital to participate in the business (e.g. joint-ventures). Which of these two forms of foreign expansion is better for the recipient economy is not clear. On the one hand, interactions with domestic agents and leakages of technology or know-how are easier if foreign investors run their businesses together with local partners. On the other hand, multinationals may be reluctant to transfer the most advanced technologies to their subsidiaries unless they have full control over them (see Ramachandran (1993)).[17]

Our dataset does not contain information on the exact share of foreign participation in a company's total capital (see footnote 7). However, it allows us to discriminate between fully-owned and majority-owned foreign companies. In order to examine whether these two different types of foreign investment matter for productivity spillovers, we redefine our measures of foreign presence. More specifically, we set F_{it} to one if the firm *i* is fully-owned (and not majority-owned as before) and zero otherwise. HZ_{jt}, BW_{jt} and FW_{jt} change accordingly. Next we repeat our estimations with these newly defined measures of foreign presence. The main results are reported in Table 7.

Having redefined foreign firms as those that are wholly-owned by non-residents, we do not find any direct spillovers to domestic firms. Now, only firms increasing their absorptive capacity seem to benefit from foreign investment. Both R&D and other innovative expenditures seem to increase a representative firm's productivity. Contrary to previous findings, we do not find any role for competition in facilitating the extent of spillovers. The results obtained may suggest that wholly-owned foreign firms are successful at preventing technology leakages to domestic firms. However, the latter seem to be able to overcome at least some of these barriers by increasing their absorptive capacity. One can also view our results as supporting the hypothesis that equity participation is a vital channel through which foreign firms' superior knowledge may spread over the host economy. This is in contrast to the results obtained by Blomström and Sjöholm (1999), according to which the degree of foreign ownership does not affect the extent of spillovers.

[17] Results obtained by Brambilla (2006) for China's manufacturing suggest, however, that there may exist production efficiencies arising from partial foreign ownership.

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Table 7. Spillovers from fully vs. majority-owned foreign firms

Regressors	Coefficients (standard errors)				
	1	2	3	4	5
Δm_{it}	0.614*** (0.010)	0.613*** (0.010)	0.613*** (0.010)	0.612*** (0.010)	0.614*** (0.010)
Δl_{it}	0.136*** (0.007)	0.136*** (0.007)	0.136*** (0.007)	0.135*** (0.007)	0.136*** (0.007)
Δk_{it}	0.068*** (0.007)	0.069*** (0.007)	0.069*** (0.007)	0.068*** (0.007)	0.068*** (0.007)
ΔHZ_{jt}	0.020 (0.024)	0.020 (0.024)	0.020 (0.024)	0.020 (0.024)	0.019 (0.024)
ΔBW_{jt}	0.190 (0.165)	0.190 (0.165)	0.191 (0.165)	0.184 (0.163)	0.271 (0.179)
RDQ_{it}		0.112** (0.057)			
$RDQ_{it} \cdot \Delta BW_{jt}$		18.658*** (5.760)	21.124*** (5.024)		
$RDQ_{it} \cdot \Delta FW_{jt}$			4.808** (2.225)		
INQ_{it}				0.034*** (0.006)	
$INQ_{it} \cdot \Delta HZ_{jt}$				1.010* (0.583)	
$HHR_{jt} \cdot \Delta BW_{jt}$					-2.502 (2.195)
$HHR_{jt} \cdot \Delta FW_{jt}$					1.399 (1.204)
Domestic firms only	Yes	Yes	Yes	Yes	Yes
Firm dummies	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes
Number of observations	94 691	94 691	94 691	94 691	94 691
Autocorrelation[a]	2.153	2.153	2.153	2.154	2.153
R^2 (adjusted)	0.541	0.541	0.541	0.542	0.541

***, ** and * denote significance at 1%, 5% and 10%, respectively.
[a] First-order Durbin-Watson statistics.

Repeating the exercise for the subset of manufacturing leads to very similar conclusions (see Table 8). The only difference is that R&D, and not necessarily innovative expenditures in general, help to increase the gains from foreign presence. We still find increasing competition leading to productivity gains in domestic firms, but not via increasing the extent of possible spillovers from wholly-owned foreign firms.

4.6. Robustness checks

To verify whether our main results are robust to alternative estimation strategies, we perform a number of checks. We restrict our attention to five preferred specifications, which are equation 5 from Table 2, equation 3 from Table 3, equation 4 from Table 3, equation 3 from Table 4 and equation 3 from Table 5. The results are reported in Table 9a, Table 9b, Table 9c, Table 9d and Table 9e, respectively. To facilitate comparisons, we repeat our baseline results in first columns of each table.

Table 8. Spillovers from fully vs. majority-owned foreign firms – manufacturing

Regressors	Coefficients (standard errors)				
	1	2	3	4	5
Δm_{it}	0.677*** (0.014)	0.677*** (0.014)	0.677*** (0.014)	0.672*** (0.013)	0.677*** (0.014)
Δl_{it}	0.100*** (0.009)	0.100*** (0.009)	0.100*** (0.009)	0.099*** (0.007)	0.100*** (0.009)
Δk_{it}	0.061*** (0.007)	0.061*** (0.007)	0.061*** (0.007)	0.061*** (0.007)	0.061*** (0.007)
ΔHZ_{jt}	-0.013 (0.026)	-0.013 (0.026)	-0.013 (0.026)	-0.014 (0.026)	-0.010 (0.026)
ΔBW_{jt}	0.223 (0.173)	0.225 (0.173)	0.227 (0.173)	0.239 (0.173)	0.061 (0.242)
RDQ_{it}		0.140*** (0.047)			
$RDQ_{it} \cdot \Delta BW_{jt}$		16.062*** (5.018)	19.185*** (4.409)		
$RDQ_{it} \cdot \Delta FW_{jt}$			6.375*** (1.944)		
INQ_{it}				0.044*** (0.016)	
$INQ_{it} \cdot \Delta HZ_{jt}$				2.094 (1.466)	
HHR_{jt}					-3.885** (1.749)
$HHR_{jt} \cdot \Delta BW_{jt}$					3.791 (3.427)
$HHR_{jt} \cdot \Delta FW_{jt}$					-0.656 (3.966)
Domestic firms only	Yes	Yes	Yes	Yes	Yes
Firm dummies	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes
Number of observations	36 338	36 338	36 338	36 338	36 338
Autocorrelation[a]	2.238	2.238	2.238	2.242	2.238
R^2 (adjusted)	0.639	0.640	0.640	0.642	0.640

***, ** and * denote significance at 1%, 5% and 10%, respectively.
[a] First-order Durbin-Watson statistics.

As can be seen from the previous sections, the sum of coefficients on productive inputs (intermediate inputs, labour and capital) is less than one, which implies diminishing returns to scale. Given some earlier studies (see e.g. Smarzynska-Javorcik (2004)), this should not be viewed as unacceptable. One might argue, however, that this is a result of a misspecified description of technology. To address this issue, we repeat our estimations imposing constant returns to scale. As can be seen from columns 2 of the relevant tables, our results remain broadly unchanged.

Table 9a. Robustness checks for equation 5 from Table 2

Regressors	Coefficients (standard errors)								
	1	2	3	4	5	6	7	8	9
ΔHZ_{jt}	0.040* (0.021)	0.039* (0.021)	0.039* (0.020)	0.038* (0.021)	0.038* (0.021)	0.043** (0.021)	0.039** (0.017)	0.035* (0.018)	0.046** (0.020)
ΔBW_{jt}	0.208** (0.106)	0.295*** (0.104)	0.238** (0.103)	0.265*** (0.104)	0.262** (0.104)	0.224** (0.106)	0.314*** (0.090)	0.225** (0.094)	0.179* (0.099)

***, ** and * denote significance at 1%, 5% and 10%, respectively.
For brevity, parameters controlling for the use of productive inputs (intermediate inputs, labour and capital) are not reported.
All specifications include a full set of firm-specific effects and year dummies. The respective columns correspond to the following specifications:
1: baseline specification
2: constant returns to scale imposed
3: separate estimation of the input coefficients for each two-digit industry
4: calibrated input coefficients using their shares in gross output
5: calibrated input coefficients using their shares in gross output and mark-ups estimated by Martins et al. (1996)
6: Translog production function
7: dynamic specification including one-period lags in output and inputs, estimated using the system GMM of Blundell and Bond (1998)
8: inputs instrumented using the system GMM of Blundell and Bond (1998)
9: Olley and Pakes (1996) correction.
See the text for details.

Table 9b. Robustness checks for equation 3 from Table 3

Regressors	Coefficients (standard errors)								
	1	2	3	4	5	6	7	8	9
ΔHZ_{jt}	0.040* (0.021)	0.039* (0.021)	0.039* (0.020)	0.038* (0.021)	0.038* (0.021)	0.043** (0.021)	0.039** (0.017)	0.035* (0.018)	0.047** (0.020)
ΔBW_{jt}	0.208* (0.106)	0.295*** (0.104)	0.238** (0.103)	0.265** (0.104)	0.261** (0.104)	0.223** (0.106)	0.314*** (0.090)	0.224** (0.094)	0.179* (0.099)
RDQ_{it}	0.215*** (0.049)	0.222*** (0.052)	0.224*** (0.049)	0.166*** (0.051)	0.164*** (0.052)	0.206*** (0.049)	0.160*** (0.050)	0.155*** (0.058)	0.200*** (0.054)
$RDQ_{it} \cdot \Delta BW_{jt}$	10.106*** (2.384)	8.004*** (2.414)	7.948*** (2.162)	7.780*** (2.263)	7.645*** (2.400)	10.343*** (2.520)	10.592*** (2.216)	11.014*** (2.522)	7.881*** (1.993)

See notes to Table 7a.

Table 9c. Robustness checks for equation 4 from Table 3

Regressors	Coefficients (standard errors)								
	1	2	3	4	5	6	7	8	9
ΔHZ_{jt}	0.040* (0.021)	0.039* (0.021)	0.039* (0.020)	0.038* (0.021)	0.038* (0.021)	0.043** (0.021)	0.039** (0.017)	0.035* (0.018)	0.046** (0.020)
ΔBW_{jt}	0.208** (0.106)	0.295*** (0.104)	0.238** (0.103)	0.264** (0.104)	0.261** (0.104)	0.223** (0.106)	0.315*** (0.090)	0.224** (0.094)	0.179* (0.099)
$RDQ_{it} \cdot \Delta BW_{jt}$	13.523*** (2.661)	11.489*** (2.721)	11.481*** (2.562)	10.365*** (2.455)	10.184*** (2.568)	13.617*** (2.857)	13.095*** (2.564)	13.262*** (2.702)	11.227*** (2.361)
$RDQ_{it} \cdot \Delta FW_{jt}$	7.070*** (2.864)	8.197*** (3.013)	8.801*** (2.897)	5.335** (2.717)	5.066* (2.754)	8.592*** (2.997)	9.215*** (2.564)	8.255*** (2.790)	7.624*** (2.874)

See notes to Table 7a.

Table 9d. Robustness checks for equation 3 from Table 4

Regressors	Coefficients (standard errors)								
	1	2	3	4	5	6	7	8	9
ΔHZ_{jt}	0.039* (0.021)	0.039* (0.021)	0.039* (0.020)	0.038* (0.021)	0.038* (0.021)	0.043** (0.021)	0.040** (0.017)	0.035* (0.018)	0.045** (0.020)
ΔBW_{jt}	0.199* (0.105)	0.289*** (0.105)	0.231** (0.102)	0.260** (0.103)	0.256** (0.103)	0.215** (0.105)	0.312*** (0.090)	0.217** (0.094)	0.172* (0.098)
INQ_{it}	0.035*** (0.006)	0.030*** (0.006)	0.029*** (0.006)	0.028*** (0.005)	0.028*** (0.005)	0.037*** (0.006)	0.034*** (0.009)	0.034*** (0.004)	0.041** (0.019)
$INQ_{it} \cdot \Delta HZ_{jt}$	1.059*** (0.547)	0.892* (0.528)	0.964* (0.567)	0.745 (0.501)	0.740 (0.502)	1.116** (0.570)	1.030 (0.791)	0.885*** (0.338)	0.792 (0.642)

See notes to Table 7a.

Table 9e. Robustness checks for equation 3 from Table 5

Regressors	Coefficients (standard errors)								
	1	2	3	4	5	6	7	8	9
ΔHZ_{jt}	0.036* (0.021)	0.036* (0.021)	0.036* (0.021)	0.034* (0.021)	0.035* (0.021)	0.039* (0.021)	0.036** (0.017)	0.030* (0.018)	0.042** (0.021)
ΔBW_{jt}	0.320** (0.128)	0.416*** (0.122)	0.324*** (0.123)	0.384*** (0.123)	0.382*** (0.123)	0.324** (0.127)	0.454*** (0.098)	0.338*** (0.104)	0.298** (0.121)
$HHR_{jt} \cdot \Delta BW_{jt}$	-3.136** (1.387)	-3.347*** (1.292)	-2.467* (1.348)	-3.282** (1.300)	-3.312** (1.307)	-2.848** (1.316)	-4.272*** (1.107)	-3.248*** (1.040)	-3.203** (1.431)
$HHR_{jt} \cdot \Delta FW_{jt}$	1.830* (0.957)	1.748* (1.001)	1.749* (0.933)	1.676 (1.090)	1.729 (1.091)	1.939** (0.919)	1.881** (0.929)	2.354** (0.967)	1.594* (0.967)

See notes to Table 7a.

Next we allow the coefficients on productive inputs to vary across industries. We do so by estimating a simple production function for each two-digit industry (i.e. we regress output on intermediate inputs, labour and capital only) and then regressing the residuals on the structural variables in interest. The results are reported in columns 3 of the relevant tables and are very similar to those obtained from our baseline specification.

Columns 4 report results for a similar two-stage procedure, but this time the elasticities of the three productive inputs are calibrated using their shares in gross output (which implies perfect competition). The results are unchanged, with two exceptions. First, the interaction of foreign presence in the same industry with the broader measure of innovation intensity as well as the interaction of the concentration index with a measure of forward spillovers become insignificant. The same holds if we correct the factor shares by industry-specific mark-ups, using the estimates from Martins et al. (1996) – see columns 5.

Our baseline description of technology is a Cobb-Douglas production function, which may be questioned as too restrictive. We address this issue in columns 6, in which we replace the Cobb-Douglas functional form with a Translog production function. This yields the results very similar to those obtained from our baseline specification.

Next we augment our baseline equations with a lagged dependent variable and lagged input variables, which should be a more relevant description of technology in the presence of short-run adjustments to shocks. In this case, OLS estimator is no longer consistent, so we estimate the equations using the system GMM method of Blundell and Bond (1998), which builds on the seminal contributions of Arellano and Bond (1991) and Arellano and Bover (1995). We find our main results qualitatively unchanged, except that the interaction of foreign presence in the same industry with the broader measure of innovation intensity becomes insignificant (see columns 7 of the relevant tables).

Finally, we deal with the possible endogeneity of the input variables. In columns 8 we instrument the three productive inputs using again the system GMM method of Blundell and Bond (1998). Columns 9 present the results obtained from the semi-parametric estimation procedure suggested by Olley and Pakes (1996). We find the main conclusions drawn from our baseline specification still valid.

5

Conclusions

The aim of this study was to add to the understanding of externalities associated with FDI in a host transition country by exploiting unique and extensive firm-level panel data covering the Polish corporate sector. We looked for possible spillovers to domestic firms not only from foreign-owned firms operating in the same industry, but also tried to find evidence for externalities arising from backward or forward trade linkages between foreign and domestic firms. Moreover, we examined the role of absorptive capacity and competitive pressure in accounting for the extent of spillovers from foreign investment. We supplemented our analysis with a wide set of robustness checks.

Our findings point to the existence of positive productivity spillovers from foreign presence in the same industry and in downstream sectors. Both horizontal and backward spillovers are economically meaningful, however the size of the latter seems to be substantially stronger. We find that domestic firms with greater absorptive capacity (measured by their research and development effort) benefit more from foreign presence in downstream and upstream industries than others. On the contrary, we do not find evidence for the role of R&D in facilitating positive horizontal spillovers. Our results suggest that domestic firms can increase the benefits they reap from foreign presence in the same industry by upgrading their stock of knowledge via investment in patents, licences, software etc., although our robustness checks indicate that this finding should be treated cautiously. According to our results, higher competition facilitates spillovers from foreign presence in downstream industries. On the contrary, there is also some (although not always robust) evidence that lower competition is associated with larger spillovers from foreign presence in upstream sectors. Our results also suggest that, unconditional on absorptive capacity of domestic firms, productivity spillovers are higher if at least some domestic capital is involved in foreign majority-owned establishments. Suppressing our dataset to manufacturing firms leads to qualitatively similar conclusions. The only exception is that we do not find evidence for horizontal spillovers from foreign presence.

Although this paper confirms the existence of positive productivity externalities associated with foreign investment, policy implications are not straightforward. On the one hand, our results provide some rationale for the use of investment incentives focusing on foreign firms. On the other hand, with many countries competing for FDI, there is the risk of overbidding, i.e. granting subsidies surpassing the level of spillover benefits (see Oman (2000)). One should also bear in mind that any subsidies create market distortions, which may lead to welfare losses.

Our findings of significant backward spillovers may be viewed as a call for policies enforcing links between foreign investors and domestic suppliers, such as local content requirements. While they might potentially have positive welfare effects on the host country, the empirical evidence of effectiveness of such policies in developing countries is rather mixed (see e.g. Greenaway (1992)). It should also be taken into account that these and similar restrictions may in fact discourage foreign investment – as pointed out by Görg and Greenaway (2003), local content requirement is equivalent to an input tariff..

In our view, the clear implications of this paper are consistent with the suggestions of Blomström and Kokko (2003). First, there are reasons to support policies strengthening absorptive capacity of domestic firms. This can be achieved either through direct subsidies to firms investing in knowledge or through country-wide policies supporting human capital formation. Second, reforms increasing competition, particularly in sectors supplying technologically advanced firms should benefit a country's growth as well. Finally, it is worth pursuing more general policies that not only attract foreign investors, but are also beneficial to domestic companies. A typical example could be policies aimed at enhancing modern infrastructure, increasing the quality of institutions or improving other fundamentals for economic growth.

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