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Are There Labour Productivity Spillovers from Foreign Direct Investment? Evidence from the Polish Manufacturing Sector, 1993–2007

Abstract: *Using panel data, this paper examines the impact of firms with foreign capital on the labour productivity of domestic firms in Poland. The econometric analysis is based on unpublished firm level data compiled by the Polish Central Statistical Office for 1993–2007. In order to examine productivity spillovers from foreign direct investment in Polish manufacturing the author makes use of the contagion and technology gap hypotheses. The former assumes that productivity spillovers from foreign firms to local ones increase in proportion to the growing share of foreign-owned firms in total production. The second hypothesis presumes that the greater are the technological gaps between foreign and local firms, the more intensive is the technology spillover. Estimated results indicate however that there were no productivity spillovers from foreign firms to local ones in manufacturing as a whole between 1993–2007. The greater technology gap actually led to less intensive spillovers for different groups of industries according to various classifications, however the results differ between groups of industries.*

Introduction

It is increasingly accepted that Multinational Enterprises (MNEs) are key players in the global generation, adoption and diffusion of technology. In particular, firms belonging to multinational groups are larger, concentrate mainly in high-tech industries, have higher productivity and pay higher wages, and demonstrate a greater tendency for innovation and R&D. This might have

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a direct impact on host countries in which average productivity and innovation increase as the share of activities due to multinationals in the economy rises. This has to do with the fact that Foreign Direct Investments (FDIs) bring in large amounts of assets which might not be available locally, such as technologies, market and employment opportunities, capital, and management skills.[1]

The relative technological advantage of MNEs also makes it plausibe that they would cause (directly or indirectly) the technological improvement of domestic firms, in particular in countries that are relatively far from the technological frontier. Prevailing theory identifies several channels through which FDI generates externalities that increase productivity in the host country. It is possible, however, for the net effect of such linkages on the welfare of the host country to be negative, if we take into consideration the impact of FDI on the profitability of domestic firms. Whether spillovers from multinationals raise a host country's welfare is an empirical question.

With the opening of the Central and Eastern European Countries (CEECs), FDI has become an important mechanism for their integration into the world economy, especially that of the EU. In the mid–1990s Poland took over the position as the main destination of FDI inflows into this region. According to the Polish Information and Foreign Investment Agency, at the end of 2007 the value of FDI inward stock accumulated in Poland throughout the transition period amounted to over 107 billion euro. The largest investment outlays in Poland were made by investors from the EU countries. The National Bank of Poland has estimated that in 2007 85.3% of FDI inflows were from these countries, mainly from France, Germany, Austria, Italy and Sweden. The most significant investment from outside the EU came from residents of United States of America, Netherlands Antilles, Republic of Korea (South Korea) and Japan. In 2007 the share of the manufacturing sector in FDI inflow was high and accounted for 20% of all FDI inflow, although this was lower than in previous years (24% in 2006, 28% in 2005 and 37% in 2004).

The objective of this paper is to examine the impact of FDI on the labour productivity of local firms in Poland. The analysis focuses on manufacturing and is based on firm level data compiled by the Polish Central Statistical Office on an annual basis. Data are aggregated up to the three-digit level of the EKD (*Europejska Klasyfikacja Działalności*, 103 industries) – the corresponding Polish equivalent of NACE (*Nomenclatures des Activites de Communite Europeene*). For two reasons, manufacturing firms only are analysed. First, the manufacturing sector comprised a high volume of FDI over the period analysed, and second the risk of liquidation of FDI due to further relo-

[1] G. Barba Navaretti, A. Venables, *Multinational Firms in the World Economy*, Princeton 2004.

cation is more severe in the manufacturing sector than in the services, financial intermediation or other sectors, where the servicing-the-market motive prevails.

There are two exclusive types of firms within each industry: locally-owned firms (domestic firms) and firms with foreign capital (foreign firms). All firms with foreign predominance in equity capital are included in the second group. Aggregated three-digit data are not provided if they refer to less than three firms. All variables were transformed into constant 1993 prices, in order to eliminate artificial effects caused by different rates of inflation.

Section 1 of the paper provides the theoretical background, while Section 2 presents the main results of statistical and econometric research.

1. Theoretical background

MNEs play an important role in transferring technology across national borders. The transfer of technology may be internalised, i.e. to their affiliates, or externalised, i.e. to other firms in the host economy. They also can have both a direct and indirect positive impact on the diffusion of technology, irrespective of their ownership and control. A MNE can stimulate technological change and learning directly through the transfer of new technology and organisational skills to its affiliates. Simultaneously its presence in the host economy may cause indirect effects in the form of technology/productivity spillovers from their affiliates to local enterprises.

The scientific literature usually identifies two types of productivity spillovers.[2] Local firms can benefit from either the presence of foreign firms in their sector (horizontal spillovers) and from interaction with foreign firms upstream or downstream in the production chain (vertical spillovers). In case of vertical spillovers, backward spillovers is the term used to designate spillovers from foreign firms to their local sub-supplier (upstream in the production chain), while forward spillovers denote spillovers from foreign-owned companies to their local customers (downstream in the production chain).

Economists try to explain the size and nature of FDI spillovers using direct and indirect approaches. The direct approach relates the productivity measures of local firms or industries to, among other things, the extent of foreign ownership in the host country. The aim of the indirect approaches is to search for different aspects of interaction between MNEs and host coun-

[2] B.S. Javorcik, *Does Foreign Direct Investment Increase Productivity of Domestic Firms? In Search of Spillovers Through Backward Linkages*, "American Economic Review" No. 94(3)/2004, p. 605–627.

try that are related to FDI spillovers. These include: competition, co-operation, human capital, and demonstration-and-imitation effects. Competition with the foreign-owned company can increase intra-industry spillovers by stimulating technology changes. Competitive pressure forces local firms to introduce new products to preserve their market share and implement new management methods to increase productivity. Co-operation between firms with foreign capital and upstream suppliers and downstream customers also increases technological spillovers. In order to change the quality standards of their suppliers, MNEs often provide resources to improve the technological capabilities of both vertically and horizontally-linked firms. Human capital can spill over from foreign to locally-owned firms by the movement of skilled labour between employers. In addition, the proximity of local firms to foreign firms can cause demonstration-and-imitation spillovers. When foreign-owned firms introduce new products and processes, they act as a sort of demonstration to locally-owned firms. Local firms may also imitate foreign firms through reverse engineering, personal contact and industrial espionage. Finally, a concentration of related industrial activity might also stimulate the creation of industrial clusters, which encourages further FDI spillovers.[3]

Not all FDI leads to technology transfer and positive spillovers. The MNE can reduce the extent of technology spillovers by limiting downstream producers to low value-added activities, or eliminate them by relying on foreign suppliers for higher value-added intermediate products. They may also limit their export to competitors. Finally, FDI can limit domestic production, especially when affiliates are set up with the main purpose of protecting existing intellectual property rights and taking out patents in the host country.[4]

By and large the theoretical literature assumes positive effects of FDI on domestic firms' productivity, primarily through the labour mobility channel[5] or through competition and demonstration effects.[6] These models outline hor-

[3] M. Knell, *FIEs and productivity convergence in Central Europe*, in: ed. G. Hunya *Integration through FDI*, Cheltenham 2000.

[4] For more theoretical background see: A. Golejewska, *Bezpośrednie inwestycje zagraniczne a proces restrukturyzacji gospodarki: aspekt teoretyczny* (Foreign Direct Investment and Restructuring of the Economy: The Theoretical Aspect), Gdańsk 2008.

[5] See: M. Haaker, *Spillovers from Foreign Direct Investment through Labour Turnover: The Supply of Management Skills*, Discussion Paper, London School of Economics, London 1999; L. Kaufmann, *A Model of Spillovers trough Labor Recruitment*, "International Economic Journal" No. 11(3)/1997, p. 13–34; A. Fosfuri, M. Motta, T. Rønde, *Foreign Direct Investment and Spillovers through Workers' Mobility*, "Journal of International Economics" No. 53 (1)/2001, p. 205–222; A. Glass, K. Saggi, *Multinational Firms and Technology Transfer*, "Scandinavian Journal of Economics" No. 104(4)/2002, p. 495–514.

[6] J-Y. Wang, M. Blomstrom, *Foreign Investment and Technology Transfer: A Simple Model*, "European Economic Review" No. 36(1)/1992, p. 137–155.

izontal spillovers. Additionally, Rodriguez-Clare demonstrates how forward and backward linkages between foreign and domestic firms can act as a possible mechanism for positive spillovers.[7]

However, the results of empirical studies are mixed. Most studies focus on the inter-industry rather than intra-industry spillovers. Among the 42 studies on horizontal productivity spillovers of FDI in developed, developing, and transition countries reviewed by Goerg and Greenaway,[8] only 20 studies reported positive and significant results. Among the studies using firm level panel data (total of 24), which the authors argue is the most suitable estimation framework, only five found positive and significant FDI spillovers, four of them in developed countries. For transition countries, only one of the eight studies confirmed positive and significant FDI spillover effects. More conclusive are the results for vertical spillovers. Among five studies focusing on vertical FDI spillovers, three found positive backward FDI spillovers and one reported positive forward FDI spillovers. Besides Javorcik, Blalock and Gertler confirmed positive vertical FDI spillovers in Latvia and Indonesia.[9]

2. Empirical results

The share of foreign-owned firms in the capital stock of Polish manufacturing companies rose from 13,3% in 1993 to 51,5% in 2007. At the same time their share in total output increased from 14% to 53%, and in total employment from 9% to 35%. The role of firms with foreign capital, as measured by their share in domestic industrial output, was stronger than that measured by their contribution to total employment in the host country. This implies that labour productivity (LP) in firms with foreign capital was on average higher than the LP of domestic industry. The fact that the share of foreign firms in domestic capital stock was higher than their share in employment means that they use more capital-intensive technologies than domestic industry as a whole. Both conclusions are confirmed by the empirical results. Comparisons of productivity levels and productivity growth in foreign–owned and domestic firms in the years 1993–2007 reveals that both the labour pro-

[7] A. Rodriguez-Clare, *Multinationals, Linkages, and Economic Development*, "American Economic Review" No. 86(4)/1996, p. 852–873.

[8] H. Görg, D. Greenaway, *Much Ado about Nothing? Do Domestic Firms Really Benefit from Foreign Direct Investment?*, "World Bank Research Observer" Vol. 19 (2)/2004, p. 171–197.

[9] Cf. B.S. Javorcik, op.cit.; G. Blalock, P. Gertler, *Welfare Gains from Foreign Direct Investment through Technology Transfer to Local Suppliers*, "Journal of International Economics" Vol. 74(2)/2008, p. 402–421.

ductivity and capital intensity of the former have been much higher than those of the latter (see Tables 1 and 2).

In 2007 the average LP and capital intensity of foreign firms was more than two times higher than that of local firms. In 1993–2007 both LP and capital intensity in firms with foreign capital rose faster than the same indicators for local firms. In 2007 both LP and capital intensity in foreign firms were more than 800% higher than in the year 1993, while in the same period the same indicators for local firms rose by nearly 300% and over 230% respectively. The growth rate of LP and capital intensity in total manufacturing amounted to above 450% and 330% respectively. This means that foreign-owned firms contributed directly to improvements in total manufacturing productivity as well in the level of capital intensity.

The productivity performance of a given industry depends not only on the direct effects of FDI, but also on the indirect impact via technological spillovers. Indirect effects are estimated by means of econometric analysis, and in this paper two well-known hypotheses concerning indirect effects are examined:

I. The contagion hypothesis postulates that productivity spillovers from foreign firms to local ones increase in proportion to the growing share of foreign-owned firms in total sector production.
II. The technology gap hypothesis postulates that the greater are the technological gaps between foreign and local firms, the more intensive are the technology spillovers.[10]

The technology level of local firms in comparison to foreign firms is often used as a proxy for absorptive capacity. Findlay shows that given a certain minimum of economic development, regions or countries with a large initial technological gap are more likely to gain from spillovers compared to more advanced regions. In contrast to this technology gap hypothesis however, some economists argue that the lower the technological gap, the more spillovers increase.[11] Kokko *et al* argue that in case of moderate technology gaps foreign technologies are most useful for local firms because they already possess the skills needed to make use of foreign technologies.[12]

[10] See: R. Findlay, *Relative Backwardness, Direct Foreign Investment, and the Transfer of Technology: A Simple Dynamic Model*, "Quarterly Journal of Economics", No. 92(1)/1978, p. 1–16.

[11] See: J. Cantwell, *Technological Innovation and Multinational Corporation*, Oxford 1989.

[12] A. Kokko, R. Tansini, M.C. Zejan, *Local Technological Capability and Productivity Spillovers from FDI in the Uruguayan Manufacturing Sector*, "Journal of Development Studies" No. 32(4)/1996, p. 602–11.

In contrast, large gaps may indicate that foreign technologies are so different from local ones that the locally-owned firms are either unable or too weak to learn from them. This hypothesis has been described as the 'technological accumulation hypothesis'.[13] However, taking into account non-linearities, firms both too close to and too far from the foreign technology frontier will benefit less from FDI than firms with a medium technological level. Weak firms will lack resources to absorb new technologies (negative spillovers), whereas for technologically advanced firms the potential to gain from spillovers will be rather limited. In this paper I chose to test the technology gap hypothesis.

In order to test both the contagion and technology gap hypotheses, I used the following regressions:[14]

$$\Delta \ln LP_{lit} = \beta_1 \Delta \ln Y(total)_{it} + \beta_2 \Delta \ln (C/L)_{lit} + \beta_3 FDI_{it} + \beta_4 (FDI_{it} * GAP_{lit}) + \beta_0 + \xi_{it} \quad (1)$$

$$\Delta \ln LP_{lit} = \beta_1 \Delta \ln Y(total)_{it} + \beta_2 \Delta \ln (C/L)_{lit} + \beta_3 FDI_{it} + \beta_4 (FDI_{it} * GAP_{lit}G1) + \beta_5 (FDI_{it} * GAP_{lit}G2) + \beta_6 (FDI_{it} * GAP_{lit}G3) + \beta_7 (FDI_{it} * GAP_{lit}G4) + \beta_8 (FDI_{it} * GAP_{lit}G5) + \beta_0 + \xi_{it} \quad (2)$$

$$\Delta \ln LP_{lit} = \beta_1 \Delta \ln Y(total)_{it} + \beta_2 \Delta \ln (C/L)_{lit} + \beta_3 FDI_{it} + \beta_4 (FDI_{it} * GAP\_L_{lit}) + \beta_0 + \xi_{it} \quad (3),$$

where *it* denotes industry *i* in time *t*, *l* means locally-owned firms, *LP* stands for labour productivity and is defined as a ratio of total output to labour input, *C/L* is the capital/labour ratio, *Δ Y (total)* measures the growth rate of aggregate output of the industry, and *FDI* stands for the share of foreign firms' output in domestic output. The variable *GAP* (technology gap) is defined as a ratio of the labour productivity of foreign firms to the labour productivity of local firms within the same three-digit NACE industry, minus one. *G1 – G5* are the groups of industries classified by different taxonomies. *GAP_L* is a dummy variable equal to 1, if local firms in the *i*th industry have a technology gap that is smaller in value than the median value of *GAP* for all domestic industries; otherwise it is equal to 0.

[13] Cf. J. Cantwell, op.cit.

[14] For details on methodology see: K. Żukowska-Gagelmann, *Productivity spillovers from foreign direct investment in Poland*, "Economic Systems" No. 24(3)/2000, p. 223–256.

In compiling the first equation I test the contagion and the technology gap hypotheses at the same time. The marginal effect of greater foreign participation on the productivity growth of local firms is given by $\beta_3 + \beta_4$. In the second regression I test the impact of FDI in different groups of industries according to various classifications. To test the technology gap hypothesis I also use the last equation. β_3 apply here to industries with a wide technology gap and $\beta_3 + \beta_4$ to the others. If $|\beta_3| > |\beta_3 + \beta_4|$, the technology gap hypothesis cannot be rejected.

To verify the latter hypothesis/ hypotheses I have compiled a panel data model, which means that the data set combined time series and cross sections observations. I used unbalanced panel data for 103 industries of Polish manufacturing in 1993–2007. It was unbalanced because in some years the number of firms in an industry was too small to publish official information or there were other problems with data in Polish Central Statistical Office, from which I received the data. As the first step in compilation of the model the explanatory variables were chosen. Then I estimated the two-way fixed effects and two-way random effects for both panel data models. For the FEM (Fixed Effects Model) I used the within estimator (which is equal to the OLS – Ordinary Least Squares with dummy variables) and the REM (Random Effects Model) was estimated by GLS (Generalized Least Squares), as I must assume that the individual effects were correlated with the disturbances. To decide which model should be used for my final interpretation I used the Hausman specification test. In each regression the conclusion was that I could not assume the explanatory variables were uncorrelated with the disturbances, so the GLS estimator was biased in each case. Therefore the final interpretation was made based on the results of the FE models. These results are presented in Table 3. For different taxonomies, see Table 5.

The estimated results are satisfactory for the purpose of our analysis, which is the impact of FDI on domestic firms, not the explanation of all changes in productivity. LP changes in local firms are significantly positively related to the changes in their capital intensity and the growth rate of aggregate output of the industry. This finding comes as no surprise. Nevertheless, the results from equation 1 suggest that there were no productivity spillovers from foreign firms to local ones in manufacturing as a whole in 1993–2007. The share of foreign firms' output in domestic output doesn't significantly affect the changes in the productivity of locally-owned firms. This lack of spillovers doesn't support the contagion hypothesis, nor does it confirm a positive impact of foreign capital on domestic producers. The results are inconsistent with the results obtained by Żukowska-Gagelmann for total Polish manufacturing in 1993–1997 as well as with our previous re-

sults for the period 1993–2002.[15] Both, using the same methodology, confirmed negative productivity spillovers in Polish manufacturing. Our previous results suggested that the aggregate productivity in a given sector might have risen at the cost of domestic firms. Competitive pressures from stronger foreign firms might have forced some domestic firms to exit the market. Some foreign firms employed wage-arbitrage and the domestic sector might not have been able to respond to wage increases. Also, privatisation might have removed local firms from the market, particularly when it encompassed the best firms. According to the results for the period 1993–2006 (Table 4)[16] and 1993–2007, one might suppose that the competitive ability of local firms may have improved.

Our assessment of the lack of significant positive spillovers arising from FDI in Polish manufacturing as a whole may be explained by a number of reasons. The medium and large-sized Polish firms examined are recognised to be not highly interactive with foreign firms, in contrast to small firms, which are much more responsive. The sectoral distribution of FDI may also be important, as it is still predominantly located in more traditional, low technology, sectors. In these sectors one may assume that the possibility of technology spillovers is less likely to occur. Finally, the results may indicate that the indirect gains are not an automatic consequence of the presence of foreign firms, but they depend to a large extent on the efforts of local firms to invest in learning or R&D activities so as to decode the spilled-over knowledge. It may be assumed that local firms would be more likely to cut production than increase investment in new technologies in response to competitive pressures from stronger foreign firms.

In assessing the results of equation 2, one can see that the greater technology gap is mostly reflected in less intensive spillovers for different groups of industries according to various classifications, This leads me to reject the technology gap hypothesis for these groups, which are characterized by high human capital intensity and low physical capital intensity; high physical capital intensity and low human capital intensity; low sensitivity to non-tariff barriers; low technology intensity and are based on blue collar skills. The technology gap hypothesis is confirmed however for industries based on very

[15] D. Ciołek, A. Golejewska, *Dyfuzja produktywności jako efekt pośredni FDI w polskim przemyśle przetwórczym w latach 1993–2002 (Productivity Spillovers as an Indirect Effect of FDI In Polish Manufacturing in 1993–2002)*, „Prace i Materiały Wydziału Zarządzania UG: Ekonometria" No. 3/2006.

[16] See: A. Golejewska, *Productivity Spillovers from Foreign Direct Investment in Polish Manufacturing in 1993–2006*, "Analizy i Opracowania KEIE Uniwersytetu Gdańskiego" No. 2/2009.

high human capital intensity and high technology. In 1993–2006 the direction of spillovers differed across these groups (see Table 4). The estimated results suggest positive productivity spillovers for industries characterised by average or low sensitivity to economies of scale; high human capital and low physical capital intensity; high physical capital and low human capital intensity; medium high technology intensity and based on blue collar skills. There were only three groups of industries where we could observe negative spillovers. These were industries characterised by high human capital and physical capital intensity; low sensitivity to non-tariff barriers, and low technology intensity.

In industries where the technology gap was smaller than the median value, the productivity spillovers of FDI were less intensive than in other industries (significant at the 10 percent level). However, for the period 1993–2006 the estimated results of regression 3 implied that the fact that a technology gap was smaller or bigger than the median value had no statistically significant impact on LP changes for local firms.

3. Concluding remarks

FDIs are considered as the creator and diffuser of new and superior technologies. If they fulfil this attributed role, then they are expected to generate some spillovers to domestic industries in host economies. Theoretical and empirical studies postulate that domestic technological capability is also important in this process.

The results suggest that in spite of the positive contribution of foreign-owned firms to labour productivity and capital intensity growth, no positive productivity spillovers to domestic firms in Polish manufacturing as a whole was observable in the period 1993–2006. Thus, the role of FDI in improving the industrial competitiveness of Poland is at the very least ambiguous. The lack of positive spillovers may be a result of the large size of the firms examined, the sectoral distribution of FDI and poor efforts on the part of local firms to invest in learning or R&D activities. Polish manufacturing would profit more if investments were located in high-technology industries employing highly-skilled or at least medium-skilled workers. But so far the majority of FDIs have been located in low-technology industries employing low-skilled workers. In order to increase productivity spillovers the government should make efforts to attract FDI to more technology-intensive industries and support R&D activities in local firms, not only on the national but also at the regional level.

Table 1. Labour productivity and capital-labour ratio in Polish manufacturing, 1993–2007, thousands PLN

	'93	'94	'95	'96	'97	'98	'99	'00	'01	'02	'03	'04	'05	'06	'07
LP (foreign)	30,4	38,2	72,1	90,3	108,6	121,9	145,9	160,0	168,7	171,2	201,3	222,1	217,4	234,5	250,0
LP (local)	36,8	40,6	50,8	50,9	63,9	67,9	70,6	80,1	84,4	90,5	97,8	86,7	93,2	108,1	113,0
LP (total)	36,5	40,5	51,9	53,5	67,6	73,5	84,4	96,7	103,6	110,1	123,3	137,5	140,1	152,3	165,0
LP (local)/ LP (foreign)	1,21	1,06	0,70	0,56	0,59	0,56	0,48	0,50	0,50	0,53	48,6	39,0	42,9	46,1	45,2
C/L (foreign)	10,5	13,0	26,3	27,6	32,0	78,0	73,7	69,2	73,7	75,8	82,2	79,3	nd	82,6	85,0
C/L (local)	17,3	16,1	18,1	19,0	21,8	23,7	26,9	28,4	31,5	35,3	35,4	26,9	nd	38,0	40,6
C/L (total)	17,1	16,0	18,6	19,5	22,7	29,4	35,5	36,8	41,1	45,1	46,9	45,6	nd	53,2	57,6
C/L (local)/ C/L (foreign)	1,64	1,24	0,69	0,69	0,68	0,30	0,37	0,41	0,43	0,47	43,1	33,9	nd	46,0	47,8

Source: CSO database, own calculations.

Table 2. Labour productivity growth in Polish manufacturing, 1993–2007, previous year=100

LP growth, %	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	average
foreign firms	125,6	189,0	125,2	120,3	112,3	119,6	109,7	105,4	101,5	117,6	110,3	97,9	107,9	106,6	117,8
local firms	110,5	125,2	100,2	125,4	106,3	104,0	113,5	105,3	107,3	108,1	88,7	107,5	116,0	104,5	108,8
total	110,8	128,1	103,0	126,4	108,7	114,8	114,7	107,1	106,2	112,0	111,5	101,9	108,7	108,3	111,6

Source: CSO database, own calculations.

Table 3. Productivity spillovers and the technology gap between foreign-owned and domestic firms in Polish manufacturing, 1993–2007

	Regressions							
Δ *ln* LP_{lit}	*total manufact. (1)*	*sensitivity to EOS (2)*	*sensitivity to IN-OUT (2)*	*factor intensity Neven (2)*	*sensitivity to NTB (2)*	*technology intensity (2)*	*employees' skills (2)*	*total manufact. (3)*
Δ *ln Y (total)*$_{it}$	**0, 430424 [0,000]**	**0, 425488 [0,000]**	**0,420543 [0,000]**	**0,416685 [0,000]**	**0,437994 [0,000]**	**0,413324 [0,000]**	**0,407821 [0,000]**	**0,427736 [0,000]**
Δ *ln (C/L)*$_{lit}$	**0, 207782 [0,000]**	**0,207465 [0,000]**	**0,207306 [0,000]**	**0,20019 [0,000]**	**0,205752 [0,000]**	**0,210451 [0,000]**	**0,203731 [0,000]**	**0,20596 [0,000]**
FD_{lit}	–0,008187 [0,845]	0,03712 [0,427]	0,006523 [0,886]	0,0859888 [0,056]	0,025715 [0,535]	0.056697 [0,220]	0,037194 [0,413]	0,012015 [0,735]
FD_{lit} * GAP_{lit}	–0,000138 [0,990]							
FDI_{it} * $GAPI_{it}G1$		–16.50599 [0,552]	–0,0004745 [0,969]	**0,025734 [0,040]**	0,002238 [0,925]	**0,0263269 [0,044]**	–0,040759 [0,238]	
FDI_{it} * $GAPI_{it}G2$		0,005782 [0,637]	–0,002147 [0,906]	**–0,081876 [0,005]**	0,006787 [0,554]	–0,032453 [0,050]	**–0,048665 [0,006]**	
FDI_{it} * $GAPI_{it}G3$		–0,011158 [0,547]	–0,0289635 [0,621]	–0,032584 [0,569]	**–0,115085 [0,000]**	–0,026783 [0,461]	– 0,018666 [0,125]	
FDI_{it} * $GAP_{lit}G4$		–0,063371 [0,060]	0,0462753 [0,661]	**–0,044453 [0,012]**		**-0,110476 [0,003**]	–0,073448 [0,334]	
FDI_{it} * $GAP_{lit}G5$				–0,130135 [0,071]				
FDI_{it} * GAP_L_{lit}								**–0,076242 [0,097]**
constant	0,022323 [0,099]	0,0453576 [0,284]	0,0221918 [0,106]	0,0168028 [0,225]	0.026668 [0,046]	0,025944 [0,060]	0,023192 [0,086]	0,22187 [0,096]
Number of observations	552	526	526	511	526	526	526	552
R^2	0,438	0,442	0,437	0,460	0,455	0,458	0,453	0,442
F	90,88 [0,0000]	50,22 [0,0000]	49,18 [0,0000]	45,68 [0,0000]	61,77 [0,000]	53,43 [0,0000]	52,47 [0,0000]	92,11 [0,000]

Source: calculations with Stata SE8.

Table 4. Productivity spillovers and the technology gap between foreign-owned and domestic firms in Polish manufacturing, 1993–2006

	Regressions							
Δ *ln* LP_{lit}	*total manufact. (1)*	*sensitivity to EOS (2)*	*sensitivity to IN-OUT (2)*	*factor intensity Neven (2)*	*sensitivity to NTB (2)*	*technology intensity (2)*	*employees' skills (2)*	*total manufact. (3)*
Δ *ln Y* $(total)_{it}$	**0,440555 [0,000]**	**0,447065 [0,000]**	**0,436313 [0,000]**	**0,426682 [0,000]**	**0,459809 [0,000]**	**0,421941 [0,000]**	**0,418551 [0,000]**	**0,441125 [0,000]**
Δ *ln* $(C/L)_{lit}$	**0,208682 [0,000]**	**0,201125 [0,000]**	**0,208893 [0,000]**	**0,192470 [0,000]**	**0,200679 [0,000]**	**0,204263 [0,000]**	**0,202259 [0,000]**	**0,209275 [0,000]**
FD_{lit}	0,054821 [0,236]	**0,153348 [0,004]**	0,094461 [0,068]	**0,181872 [0,000]**	**0,112204 [0,015]**	**0,144457 [0,005]**	**0,116237 [0,022]**	0,030506 [0,416]
FD_{lit} * GAP_{lit}	-0,010683 [0,368]							
FDI_{it} * $GAPI_{it}G1$		*dropped (lack of data)*	–0,007012 [0,574]	0,013814 [0,285]	–0,034688 [0,190]	0,015950 [0,237]	–0,071495 [0,062]	
FDI_{it} * $GAPI_{it}G2$		-0,001211 [0,923]	–0,027840 [0,170]	**-0,116758 [0,000]**	–0,002331 [0,844]	**–0,049503 [0,005**]	**–0,057304 [0,002]**	
FDI_{it} * $GAPI_{it}G3$		**–0,043398 [0,037]**	–0,058018 [0,351]	–0,056359 [0,363]	**–0,154519 [0,000]**	–0,058856 [0,122]	0,005842 [0,651]	
FDI_{it} * $GAP_{lit}G4$		**–0,124148 [0,001]**	–0,091827 [0,653]	**–0,059736 [0,001]**		**–0,150514 [0,001**]	–0,114325 [0,203]	
FDI_{it} * $GAP_{lit}G5$				**–0,222969 [0,003**]				
FDI_{it} * GAP_L_{lit}								–0,012355 [0,866]
constant	0,010056 [0,480]	0,003566 [0,807]	0,006299 [0,665]	0,002043 [0,886]	0,011224 [0,422]	0,012115 [0,398]	0,008931 [0,529]	0,012371 [0,377]
Number of observations	493	472	472	458	472	472	472	493
R^2	0,448	0,463	0,450	0,484	0,473	0,474	0,465	0,447
F	82,71 [0,0000]	55,95 [0,0000]	45,36 [0,0000]	44,10 [0,0000]	58,37 [0,0000]	50,15 [0,0000]	48,25 [0,0000]	82,36 [0,000]

Source: calculations with Stata SE8.

Table 5. Taxonomies used in regressions

1.	sensitivity to economies of scale EOS,[17]	very high sensitivity to EOS, high sensitivity to EOS, average sensitivity to EOS, low sensitivity to EOS
2.	sensitivity to input-output connections IN-OUT,[18]	very high sensitivity to IN-OUT, high sensitivity to IN-OUT, average sensitivity to IN-OUT, low sensitivity to IN-OUT
3.	factor intensity,[19]	very high human capital intensity, high human capital intensity and low physical capital intensity, low human capital and physical capital intensity, high physical capital intensity and low human capital intensity, high human capital and physical capital intensity
4.	sensitivity to non-tariff barriers NTB,[20]	high sensitivity to NTB, average sensitivity to NTB, low sensitivity to NTB
5	technology intensity,[21]	high technology industries, medium high technology industries, medium low technology industries, low technology industries
6.	level of employees' skills WIFO 2.[22]	Low/unskilled, blue collar skills, white collar skills, highly skilled

Source: own tabulations.

[17] See: M. Amiti, *Specialisation Patterns in Europe*, "Weltwirtschaftliches Archiv." Vol. 135 (4)/1999; T. Brodzicki, *Konkurencyjność międzynarodowa polskiego przemysłu (International Competitiveness of Polish Industry)* in: *Potencjał konkurencyjny polskiego przemysłu w warunkach integracji europejskiej (Competitiveness of Polish Industry in European Integration)*, ed. A. Zielińska-Głębocka, Wydawnictwo Uniwersytetu Gdańskiego, Gdańsk 2003.

[18] Cf. T. Brodzicki, op.cit.

[19] D. Neven, *Trade Liberalization with Eastern Nations: How Sensitive?*, "CEPR Discussion Paper", No. 1000/1994, Centre for Economic Policy Research, London.

[20] Cf. T. Brodzicki, op.cit.

[21] OECD, *Industry and Technology – Scoreboard of Indicators*, Paris 1995.

[22] M. Peneder, *Intangible Investment and Human Resources*, *The new WIFO taxonomy of manufacturing industries*, "WIFO Working Papers", No. 114/1999.