Transmission of Knowledge and Innovation into Poland:
Role of Trade and Foreign Investment

Małgorzata Jakubiak
CASE, Warsaw

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Abstract

This research aims to assess the relative importance of high-technology imports and MNE activity for the total factor productivity of Polish manufacturing industry. The paper also examines the effect of R&D activities of domestic firms, over the period of 1995-1999. The most important and robust finding of this research is that the inflow of foreign technology matters for the productivity of domestic industries.

The results of econometric estimation suggest that there exist intra-industry spillovers deriving from imports of more technologically-advanced commodities to the same industry. Technology, or know-how, created by foreign R&D investment is transmitted into domestic manufacturing industries, and enhances their growth. It is difficult to assess the influence of domestic technology stock on the improvement of productivity of domestic industries. If anything has an effect, then these are rather spillovers from R&D embedded in intermediates from other industries used in the production of a given industry. The effects of FDI-related R&D stock are also inconclusive.

However, it is possible that, given the productivity-increasing foreign technology inflows, Poland can benefit from further productivity improvements by the development of its 'lower-tech' sector. Broadly defined, lower-technology export of this type already accounts for a significant part of Polish exports and has been growing continuously during the last years.

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Contents

Introduction

Technology diffusion can occur through a variety of channels transmitting ideas and knowledge. Possible important paths for such transmission are among others: imports of high-tech products, foreign direct investments by multinational corporations and acquisition of human capital. This research aims to assess the relative importance of the first two factors of technology transmission into Poland, namely the high-technology imports and FDI inflows for the total factor productivity of Polish manufacturing industry.

Poland is a country where industries did not manage to accumulate substantial stock of knowledge and technology. Domestic spending on R&D was severely cut-off at the beginning of the transformation process (the first half of the 1990s). Even now, R&D expenditures in relative terms are lower than in other countries in the region (*e.g.* Hungary, Slovenia), and as far as government policy is concerned, it lacks efficiently enforced, clearly defined objectives. Still, the existence of some stock of technology and the perceived relatively high quality of human capital suggests that there is some absorptive capacity within the Polish industry.

The country has opened up, and re-orientated its trade flows towards more developed economies. This gave rise to high-technology imports from the West, as well as encouraged one of the biggest FDI inflows in the region. Assuming that trade and foreign investment determine a country's access to foreign technologies embodied in advanced intermediate goods, one can expect that that there has been a transfer of innovation and that this transfer has helped in productivity improvement. This research examines the effect of R&D activities of domestic and foreign firms, and high-tech imports on the productivity of Polish manufacturing industries during the period of 1995-1999. It examines the technology content of trade coming to Poland from eight OECD economies which are the source of about 90% of the world's R&D: Germany, Italy, France, the Netherlands, Sweden, the UK, Japan, and the US.

The rest of the paper is organised as follows: issues of technology transmission and the model of technology transmission are discussed first, then follows a discussion on R&D intensity, technology stock and the productivity of Polish manufacturing industries, and a description of estimation techniques and results. This paper concludes with a section examining prospects for specialisation in low-tech, easily-imitable exports. A description of variables is in the appendix.

The role of trade and FDI in the transmission of technology

This research is trying to assess the relationship between accumulated technology stocks and the productivity of Polish industries. The relationship is supposed to capture the elasticity of TFP with respect to domestic, FDI-related, and foreign R&D. This section discusses ways in which foreign technology may be transmitted to domestic industry.

Investment in new technologies increases productivity of a given firm or an industry in a direct way. An industry may also benefit from other industries' investments through trade in intermediates. However, these channels of influence over productivity may be equally important as import of technology in the case of a transition country, like Poland. As it is shown in the following sections, domestic R&D in Poland has not been large enough to build technology stocks of significant magnitude, able to support high rates of productivity growth. Inflows of technology-embedded goods can thus enhance productivity of domestic industries through some spillover effects, provided that the host country has sufficient absorptive capacities. Keller (1997, after Romer, 1990 and Ethier, 1982) writes that thanks to technology-embedded imports the host country can get access to R&D investments. The importing country benefits by employing these intermediates in production, because it does not have to be the one that invents new construction designs. And hence it can capture foreign R&D or the technology content of a good. According to this reasoning, productivity increases as more types of high-tech intermediates are employed in production.

The empirical results of tests of this concept obtained by Keller (1997), on a group of eight OECD countries (Canada, France, Germany, Italy, Japan, Sweden, the UK, and the US) for the period 1970-1991, indicate that the estimate of elasticity with respect to own-industry R&D is between 7% and 17%. Additionally, the hypothesis of the benefits from other industries' technology investments was confirmed. What is interesting, and what should be also of significant importance in the case of Poland, is that the benefit derived from foreign R&D in the same industry for the TFP was in Keller's paper of the order of 50-95% of own R&D.

The same author in his later work (Keller, 2000, and 2001) found that technological knowledge spillovers has became more global during 1970-1995, and that the role of trade and FDI in spreading out the benefits of innovation has became increasingly important. That is, the importance of foreign R&D relative to domestic R&D has grown over time in terms of raising the productivity of domestic industries. Keller (2001) estimated – for the group of world's seven major industrialised countries - that trade patterns accounted for the majority of all differences in bilateral technology diffusion.

Now let's turn to the reasons of how productivity of an industry may be enhanced by the activities of multinational enterprises. The assumption used in this paper is that if a foreign firm invests in developing new technology in a host country, positive spillovers to other firms arise, thus having beneficial effect over productivity for the whole industry. Blomstrom (1991) presents three ways in which the technology transfer from the MNEs operating in the same industry may occur. First, the entry of strong and technologically advanced enterprises increases the competition in a given industry, therefore forcing local firms to adopt more efficient methods in production. Next, MNEs may speed up the process of technology transfer by forcing domestic firms to hasten their access to a specific technology, which they would not have been aware of otherwise. Finally, the training of labour and local managers is an important source of gains for the host economy. As the empirical evidence, cited by Blomstrom (1991) suggests, this last gain – managerial training – is of great importance in the host countries that have a significant productivity gap with FDI-producing countries. However, data used in this study do not allow capturing this last influence.

Other industries may benefit from the technology accumulated by foreign firms as well. Blomstrom (1991) writes that such gains may take the form of enhancing complementary production by local suppliers. Suppliers may compete for the MNEs supply market by lowering costs, engaging in R&D and improving productivity. However, as Blomstrom (1991) writes, there is not enough direct empirical evidence on this type of inter-industry MNEs spillovers. Only the perception that these types of spillovers are also of great importance.

The existing empirical results concerning the impact of FDI on domestic productivity are mixed. Görg and Strobl (2001) provide a survey on this subject. They review 12 published and unpublished studies in which the effects of FDI on productivity led to different results. The authors concluded that FDI spillovers are far from being 'catch all' concept and that different firms may benefit or suffer due to their presence. At the industry level, it is also possible that if multinationals gravitate towards more productive industries, there may be a positive association between sectoral productivity and FDI-related activity or foreign presence, even without the existence of spillovers. What's more, the research design matters for obtaining significant coefficients on MNEs presence, and studies that report the existence of spillover effects tend to be published. Therefore, it is hard to expect whether the coefficients on variables that describe the effect of FDI spillovers on productivity of domestic industries in this work will be significant or not.

From empirical literature on the subject, that covers geographically close and similar economies, Görg and Strobl (2001) report that Djankov and Hoekman (2000) found negative effects of foreign presence on Czech manufacturing firms. Contrary to this, Kinoshita (2000) found that the presence of multinationals had a positive effect on the productivity growth of Czech manufacturing firms, on the condition that domestic firms engaged in R&D. The results of her research suggest that for improving productivity, the interaction of foreign presence and domestic R&D is more important than a firm's own R&D intensity.

Theoretical model

The theory on which the rest of the paper is built is the model of R&D-driven growth by Keller (1997) with slight modifications. This model predicts that technology – in the form of R&D spending – can spill-over from other sectors of economy and from abroad, due to the existence of trade in differentiated intermediate goods. The difference between Keller's model and the specification used in this paper is that the author of this paper allowed for the existence of spillover effects due to the activities of foreign firms in a host country.

Let's start with the Keller (1997) model and with the assumptions of an industrial output of a given sector *j* produced with constant productivity and the use of two factors according to the Cobb-Douglas production function:

$$z_j = A_j l_j^{\alpha} d_j^{1-\alpha}, \qquad (1)$$

where l_j stands for labour services and d_j for the other, non-homogenous factor of production. This factor consists of some varieties of an intermediate good x_j, which are employed in its production (denoted n_j^{de}). Some other varieties of x_j are the results of the production process (n_j^p), and their stock at any given time is equal to the cumulative R&D resources at this time[1].

[1] Keller (1997) specifies the relation between the non-homogenous factor of production *d* and an intermediate good *x* for an industry *j* as $d_j = \left(\int_0^{n_j^{de}} x_j(s)^{1-\alpha} ds \right)^{\frac{1}{1-\alpha}}$.

Keller (1997) assumed that in order to produce one unit of an intermediate input x_j, there is a need to devote one unit of output of a given sector. Then if we treat one unit of sectoral output as an investment, the cumulative sectoral output (*i.e.* the capital stock) devoted to the production of an intermediate good, will be equal to $k_j=n_j^p x_j$.

If we were to express the other, non-homogenous factor of production in terms of capital, and substitute it into the production function, then the production function becomes: $z_j = A'_j (n_j^{de})^\alpha l_j^\alpha k_j^{1-\alpha}$, (2)

which is a more familiar formulation. Then, if the total factor productivity index is defined as $f_j^* = \frac{z_j}{l_j^\alpha k_j^{1-\alpha}}$, the change in the TFP can be approximated as: $\log f_j^* = \log A_j^{'} + \alpha \log n_j^{de}$.

Now, the assumption on the range of intermediates employed in a given sector is that it is related to the observable range of intermediates produced in this sector (n_j^p) and the weighted sum of ranges of intermediates of all other sectors. The weights in Keller (1997) are given by the input-output relations of the sectors.

Thus, for a closed economy, the effective, domestic R&D stock that influences productivity of an industry is a sum of the own-industry R&D and other-industries' R&D effect. This last effect ($b^{io}{}_j$) is an input-output weighted stock of R&D efforts undertaken in other sectors of the economy. Then, the TFP growth becomes:

$$\log f_j^* = \log A_j^{'} + \alpha \log(b_j + b_j^{io}) . \quad (3)$$

If we introduce trade with other countries, then the number of intermediates employed in a given sector, depends also on the effect from foreign R&D. The range of intermediates n_j^{de} from the above becomes:

$$b_j^{de} = b_j + b_j^{io} + b_j^f + b_j^{f,io}; \quad (4)$$

where b_j^f is the same sector, foreign technology stock effect (foreign R&D weighted by the respective countries' trade shares), and $b_j^{f,io}$ is the other industries, foreign R&D effect on domestic sector *j*. This last variable is weighted by the trade shares and by the input-output relations.

If a possibility of foreign capital investment is introduced into Keller's model (1997), the outcome is not changed much. In the closed economy case, the term d_j in the equation 1 is composed of an intermediate good x_j, produced both by domestically owned firms and foreign subsidiaries. In the equilibrium, the capital stock is equal to: $k_j = x_j (n_j^{pd} + n_j^{pf})$ where n_j^{pd} and n_j^{pf} are the number of intermediates invented in locally-owned firms and foreign-owned firms, respectively, and are equal to the respective R&D stocks.

The production function is unchanged: $z_j = A''_j (n_j^{de})^\alpha l_j^\alpha k_j^{1-\alpha}$.

The number of intermediates employed in the production is modelled as the weighted sum of ranges of intermediates employed by all sectors, with the distinction between these domestically- and foreign-owned. That is, $n_j^{de} = n_j^{pd} + n_j^{pf} + \sum_{v \neq j}^{J} \omega_{jv} n_v^{pd} + \sum_{v \neq j}^{J} \omega_{jv} n_v^{pf}$, where ω_{jv}'s are the input-output weights.

When we add to the above the concept of foreign R&D influencing productivity of domestic industries, we get the formula for the cumulative R&D resources that matter for the productivity of a given sector:

$$b_j^{de} = b_j + b_j^{io} + b_j^{FDI} + b_j^{FDI,io} + b_j^{f} + b_j^{f,io} \quad (5)$$

R&D stock in Poland and in technologically advanced OECD countries

Polish firms spend relatively little on research and development, even when compared to their counterparts in the region. Research and development intensity, as measured by the ratio of business R&D expenditures to value added, had a level of 0.92% in 1999 for the whole manufacturing sector. The average R&D intensity during 1995-1999 – 0.74% - was even lower. Kinoshita (2000) in her firm-level study of manufacturing enterprises reports that the same indicator for the period 1995-1998 was about 20 times higher in the Czech Republic. The aggregate result for Poland is biased downwards, because only a fraction of firms whose data are included in the aggregate value added was surveyed for R&D activities, and hence it cannot be strictly comparable with firm-level data. However, the difference in the intensity of R&D spending between the two countries is so large that the aggregation bias does not seem to explain it wholly. A more comparable indicator, total R&D spending (*GERD*) to GDP was 0.72% in Poland while it was 1.26% in the Czech Republic in 1998 (GUS, 2001: 29; 83, after OECD, 2000).

The R&D effort is especially visible in machinery (R&D intensity of 3.54% in 1999) and electrical machinery (2.63%), motor vehicles (1.82%) and other transport equipment (3.30%), pharmaceuticals (2.95%), and TV, radio and communication equipment (2.35%) industries. These are branches (with the exception of manufacturing of motor vehicles) which used to be classified as human capital intensive in developed countries[2]. Moreover, these are exactly the same industries that are the most R&D-intensive in developed economies[3]. The Polish industry is following the same patterns in R&D allocation as the developed-countries' manufacturing sectors. The gap is in the amount of R&D spending relative to production (or value added), which is still very low in Poland. There is probably an absorptive capacity within R&D intensive industries and one can expect that foreign, same-industry R&D has a significant influence on the growth of productivity.

When we look at the technology stocks, which are calculated using cumulative data starting from 1995, we see that the technology stock in Poland is highly concentrated in a group of industries (Table 1). Five industries out of 23 attracted over 80% of the total R&D stock in 1995, namely: machinery and electrical machinery industry, other transport equipment, motor vehicles, and chemical industries. Although this concentration is gradually decreasing, still in

[2] The specification of Neven (1994) can serve as a benchmark. Neven (1994) clustered German manufacturing industries according to their factor content. The industries that turned out to be technology intensive in Poland in 1999 belong mainly to the Neven's group 1 and 2 (with the exception of manufacturing of motor vehicles – with high labor and capital intensity), characterized by the high human capital intensity (and either high or low intensity of conventional capital).

[3] Keller (1997) calculated R&D intensity across industries by relating R&D spending to production for a group of eight OECD countries for the period 1970-1991. Four industries (ISIC Rev.2: 383, 384, 351+352, and 382+385) turned out to be leaders in technological intensity, with the scores on the technological intensity scale much higher than other branches. These are exactly the same industries that were most technology intensive in Poland in 1999 (*i.e.* ISIC Rev.3: 31, 32, 34, 35, 24, 29, 30, and 33; see Figure 2 in the Appendix).

1999 over ¾ of the total business technology stock of manufacturing was located in the same group of industries.

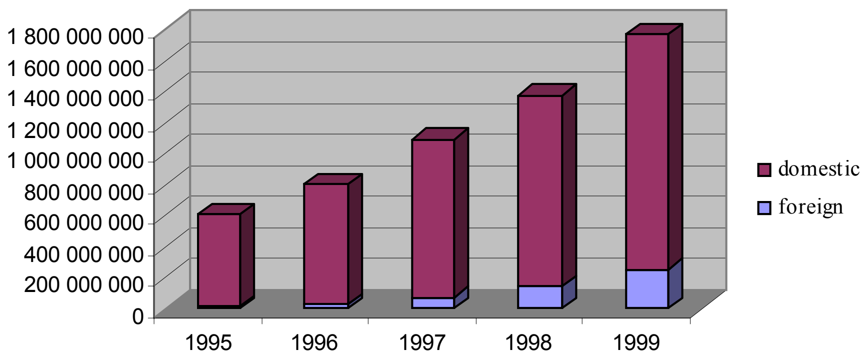
Table 1. Technology stocks for some Polish manufacturing industries, 1995-1999

	ISIC Rev.3 Industries	1995	1999	Percentage share	Average annual growth 1995-1998
29	Machinery, nec	106 830	331 516	0.195	0.329
31	Electrical Machinery	81 132	239 237	0.141	0.311
35	Other transport equipment (ships, aerospace, other)	92 544	219 609	0.129	0.245
34	Motor Vehicles	50 159	183 580	0.108	0.386
24-2423	Chemicals (less Pharmaceuticals)	48 412	173 910	0.102	0.382
2423	Pharmaceuticals	42 536	151 076	0.089	0.382
	Other	92 364	400 159	0.236	..
15...37	**TOTAL MANUFACTURING**	**513 978**	**1 699 087**	**1.000**	**0.350**

Source: own calculations
Note: technology stocks are expressed in thousands of PPP adjusted constant 1996 US dollars

The R&D effort in Poland is carried mainly by domestically-owned firms. Foreign firms accumulated only 14% of the total technology stock in manufacturing up to 1999 (Figure 1). And still, when compared to other OECD countries, Poland has one of the lowest shares of foreign engagement in R&D activities done on its territory (GUS, 2001: 50). This is a mirror image of Ireland (or Spain), where the dynamic growth of the 1990s was highly supported by R&D-intensive activities carried out mainly by multinational investors.

Figure 1. Distribution of R&D stock in Poland between locally-owned and foreign firms



Source: own calculations
Note: technology stocks are expressed in thousands of PPP adjusted constant 1996 US dollars

For this reason, it seems reasonable to expect that the influence of FDI-related R&D on the productivity of manufacturing industries is not significant. Probably, multinationals coming to Poland tend rather to concentrate on developing production and distribution platforms exclusively for their existing product lines, but not on improving the region's innovative capacity.

The possibility of getting interesting results from the estimations of the effects of high-technology imports on productivity of domestic industries seemed more probable. First of all, for the reason that R&D stock in Poland is very small when compared to technological leaders. It can be seen from Table 2 that even when adjusting for PPP, Poland has a very low level of technology stock. Poland managed to generate about 6 percent of the Dutch technology stock, and about 0.1 percent of the US R&D stock in 1998. The gap between Polish and developed economies' technology stocks is narrowing, as Polish R&D spending grow at a high rate. Nevertheless, this gap is substantial. Taking into account these differences, it becomes questionable whether Polish domestic enterprises can generate enough R&D able to significantly increase productivity of domestic industries. It is also doubtful whether absorptive capacities of the Polish manufacturing sector are enough, so the country can benefit from foreign technology stock, in the form of imported technology-embedded products.

Table 2. Technology stocks of manufacturing sectors for some OECD countries, summary statistics

Country	1987	1995	1998	average annual growth 1987-1998
US	508 251	796 761	895 699	0.053
Japan	155 563	347 590	409 033	0.093
Germany	108 319	188 244	206 094	0.061
France	58 935	110 363	120 456	0.068
UK	56 464	92 141	98 347	0.052
Italy	31 310	48 867	50 283	0.044
Sweden	10 885	21 801	27 315	0.088
Netherlands	15 003	21 855	23 808	0.043
Poland	n.a.	514	1 302	0.350*

Source: own calculations

Notes: technology stocks are expressed in millions of PPP adjusted constant 1996 US dollars; * average for 1995-1999

Table 3. Own-industry R&D imports from technological leaders, 1995-1999

Country	1995	1998
US	44 303	71 439
Japan	8 942	11 096
Germany	43 730	49 598
France	4 955	7 671
UK	5 277	4 937
Italy	6 685	3 979
Sweden	703	780
Netherlands	1 031	888
Total imported R&D	**115 627**	**150 387**
Poland	**514**	**1 302**

Source: own calculations

Notes: technology stocks are expressed in millions of PPP adjusted constant 1996 US dollars; they are weighted by respective country and industry import share, and then aggregated

The issue of being able to exploit incoming technology embedded trade is clear when we consider data from Table 3. Own-industry technology import effect is very high when compared to the domestically accumulated R&D. Total domestic technology stock was of the magnitude equal to 1% of total same-industry technology imports from most developed Poland's trading partners in 1998.

And it should be remembered that these numbers are only for the R&D stock embedded in imported commodities from the same industry. The effect of trade in intermediates from other industries (which is much higher than own-industry effect for some sectors) is not captured in Table 3.

Productivity of Polish industries

Let us now turn to the productivity of domestic industries. Sectors that spend more on creating new technologies have been on average more productive during 1994-1999. Second column of Table 4 shows that total factor productivity for the group of industries with high R&D spending[4] was growing faster than TFP for all manufacturing sectors. This result suggests that there is an important link between higher technology stock and productivity growth of manufacturing industries in Poland, which in turn increases hopes for the existence of absorptive capacities.

Table 4. Average TFP growth and TFP growth differences, Polish manufacturing industries, 1995-1999

	TFP growth: total manufacturing	TFP growth difference*		
		industries with substantial presence of R&D	industries with relatively high presence of foreign R&D	
			6 most important	3 most important
1995	-0.021	0.309	-0.030	0.240
1996	-0.177	0.011	0.096	0.248
1997	0.237	-0.002	-0.053	0.022
1998	0.057	-0.008	0.002	-0.039
1999	0.000	0.044	-0.027	-0.113
average 1994-1999	0.019	0.071	-0.002	0.072

Source: own calculations

Note: * calculated as the difference between TFP growth for the given group of industries and TFP growth for the whole manufacturing sector

On the contrary, what is true for the whole manufacturing industry does not seem to be valid for its part, *i.e.* for multinational R&D. Foreign, own-industry R&D seems to be much less connected with higher than average productivity growth. Taking into account the fact that multinationals spend very little on the development of new technologies in Poland in general this may not come as a surprise. Six industries that attracted the majority of foreign R&D turned out not to differ significantly in their productivity growth from the average. Only three industries, with highest foreign technology stock (manufacture of motor vehicles, pharmaceuticals, and electrical machinery) are on average more productive. Data suggests that higher productivity of an industry is associated more with the presence of multinationals and positive linkages that this presence creates, making domestic producers to invest in new technology to stay competitive, rather than building technology stocks by foreign firms in Poland.

[4] These were: manufacture of machinery, chemicals (including pharmaceuticals), electrical machinery, motor vehicles, TV, radio and communication equipment, other transport equipment, and rubber and plastic products.

Estimation results

Having calculated all the variables, described in details in Appendix I, the data set of 95 observations (across 19 industries over 1995-1999 period) is used to estimate the following relationship:

$$\ln f_{i,t} = \eta_0 + \beta_1 \ln(b_{i,t}) + \beta_2 \ln(b_{i,t}^{i,o}) + \beta_3 \ln(b_{i,t}^{FDI}) + \beta_4 \ln(b_{i,t}^{FDI,i,o}) + \beta_5 \ln(b_{i,t}^{f}) + \beta_6 \ln(b_{i,t}^{f,i,o}) + \varepsilon_{i,t} \quad (6)$$

Where: $f_{i,t}$ – total factor productivity index (at time t)

$b_{i,t}$ – own industry technology stock index (domestically-owned production only)

$b^{i,o}_{i,t}$ – other sectors technology stock index (domestically-owned production only)

$b^{FDI}_{i,t}$ – own industry, foreign-owned firms technology effect indicator

$b^{FDI,i,o}_{i,t}$ – other sectors, foreign-owned firms technology effect indicator

$b^{f}_{i,t}$ – own industry, foreign technology effect indicator

$b^{f,i,o}_{i,t}$ – other sectors, foreign technology effect indicator

$\eta_0, \beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6$ – constants

This is the extended and simplified version of the eq. 4.1 in Keller (1997: 20). The method to be applied is pooled least squares. In some cases, the equation had to be estimated with fixed effects. These are marked as ‘sector dummies’ in Tables 5 and 6 below.

It is possible that the estimates are biased because of simultaneity problems. One remedy to this would be an instrumental variables specification. However, as goods instruments are difficult to get, the author of this report decided to estimate the above form of the relationship, derived from the production function specified in the theoretical section. The possibility of simultaneity bias is reduced by the choice of specification of variables (after Keller, 2000). For example, GDP PPP deflators are used in the construction of the explanatory variables, while industry specific deflators are used for the left-hand side variable.

The other, and perhaps more worrisome issue related to the estimation of the relationship (6) is the possibility of misspecification or the fact that some important influences are not captured, *i.e.* that there is an omitted variable problem. But again, this cannot be solved without good instruments, and the inclusion of patenting or licensing in not viewed as a better representation of the innovative processes in the economy than R&D expenditures. Besides, as Angrist and Krueger (2001) argue, the small sample size effect may lead to the inclusion of instruments that provide more biased estimates than the original least squares estimates. Therefore, no instrumental variables are used.

Since data on foreign R&D in Poland are incomplete (small number of enterprises surveyed[5]), observations on some industries had to be dropped. Therefore, the author repeated estimation of equation (6) in the reduced form, i.e. without the effects of FDI-related R&D, and with a larger number of observations. That is, the following relationship was examined after specification (6):

$$\ln f_{i,t} = \eta_0 + \beta_1 \ln(b_{i,t} + \beta_2 b_{i,t}^{i,o} + \beta_5 b_{i,t}^{f} + \beta_6 b_{i,t}^{f,i,o}) + \varepsilon_{i,t} \quad (7)$$

[5] The small number of enterprises surveyed leads to a situation where in some categories the R&D effort is either highly concentrated or where less than 4 firms are questioned. This means that such data cannot be released by the Statistical Office.

It was assumed that foreign technology embedded in goods takes time to influence productivity of the technology-importing country. To control for this effect, a new, lagged variable was constructed (as a product of lagged values of foreign technology stock and present import weight). The results of this specification are in equations 8 and 10 of Table 6 below.

Turning to the anticipated results, the author expected to get significant influence of imported R&D and domestic R&D over productivity growth. Given the data on the R&D activities of foreign firms in Poland, it was foreseen that problems may be posed by the FDI-related R&D effect. This is because R&D stock of multinationals operating in Poland is relatively small and its effects on productivity may be difficult to capture for the whole manufacturing sector.

After having estimated the relationship (6), the following conclusions can be drawn. The full specification results in too few observations. Industries with no FDI-related foreign R&D stock had to be dropped, so the equation is not stable, and the results inconclusive.

Nevertheless, if we were to interpret these results, a first observation is that the model does not capture the influence of technology stock accumulated by multinationals in Poland on productivity of Polish industries (the coefficient on technology stock of multinationals present in Poland loses its importance once we allow for trade in intermediates or for technology inflow in the form of imported goods). Probably the relationship between activities of multinationals and productivity growth is more complex, and involves not only pure R&D investment, but also its interactions with other factors, such as foreign presence. For example Kinoshita (2000) in her study on Czech manufacturing firms finds that such interaction effects matter for the productivity of domestic industries. Why can the inclusion of such interaction effect be a solution here? Because the effect of employing technology developed at home in the production in the host country is also of significant importance[6]. Inclusion of the interaction effect may correct the results for the "R&D at home" effect. However, given the small sample size and poor availability of data this approach was not pursued further and it is beyond the scope of this paper.

Secondly, the influence of technology accumulated by domestically-owned firms on productivity of domestic industries is not clear. What's more, technology imports tend to reduce productivity for the group of industries, where foreign firms conduct their own R&D in Poland. This last result is particularly questionable, because one would rather expect the occurrence of positive spillovers in this case.

The results obtained for the smaller sample should be treated with caution. They probably suggest the existence of more complex relations. Therefore, there is a need to look at a larger sample, and this is possible only if we give up the idea of differentiating between R&D accumulated by multinationals and by domestically-owned firms.

[6] Calculation of the full effect, FDI-related foreign R&D poses many difficulties, and it is practically impossible at the industry level. The variable which would capture this effect would have to be composed of the host-country R&D and home country R&D component for foreign multinational firms. And since industry level data on the R&D spending of MNEs which have their research located abroad is hard to get, only a part of this effect is captured in this study.

Table 5. Domestic, FDI-related, and imported technology stock

	Eq. 1	Eq.2	Eq.3	Eq.4
Same sector, domestically-owned firms' R&D	-0.0326 (0.0261)	-0.0674* (0.0359)	0.0411* (0.0213)	-0.0905** (0.0442)
Other sector, domestically-owned firms' R&D		0.0191 (0.0816)	0.0533* (0.0279)	0.0345 (0.0898)
Same sector, FDI-related R&D	0.0203** (0.0098)	0.0127 (0.0117)	0.0117 (0.0102)	0.0031 (0.0131)
Other sector, FDI-related R&D		0.0162 (0.0280)	-0.0284 (0.0209)	0.0493 (0.0328)
Same sector, foreign R&D			-0.0354* (0.0195)	-0.1272** (0.0619)
Other sector, foreign R&D				-0.1699 (0.2545)
Sector dummies	yes	yes	no	yes
F-statistic (p-values)	16.391 (0.0000)	63.244 (0.0000)	2.3111 (0.0618)	38.032 (0.0000)
Adjusted R^2	0.8041	0.7961	0.1272	0.7947
Number of observations	46	46	46	46

Notes:
(1) dependent variable = log of productivity index
(2) constant was included and was significant, but is not reported here
(3) heteroskedasticity-consistent standard errors in parentheses; ** and * indicate 5% and 10% significance, respectively
(4) foreign R&D is legged by one year; it is a product of present import weight and foreign R&D stock, lagged by one year

When we turn to the estimation of the relationship (7), on the larger sample, it is still difficult to assess the influence of domestic technology stock on the improvement of productivity of domestic industries. If something has an effect, then these are rather spillovers from R&D embedded in intermediates from other industries used in the production of a given industry. The existence of these spillovers may even cause TFP to increase by over 8%, following a one percent rise in other sectors' domestic R&D indicator. However, the results are not robust, and sometimes they coexist with the negative influence from domestic own-industry R&D capital. It can be interpreted that domestic investment in R&D has not started to be productive yet. Or that even accumulated intramural R&D expenditures are not related to the productivity improvements but to some other factors.

Foreign technology inflow matters for increasing productivity of domestic industries. The inclusion of lagged values of technology stock suggests that the influence occurs through imports of same-industry technologically-advanced goods. And that the elasticity of TFP with respect to the own-industry foreign technology inflow is in the range of 3%. Contrary to this, the inclusion of variable that captures immediate influence of foreign technology on productivity of Polish industries (and the estimations done on a smaller number of observations) suggests rather that the spillovers are coming mostly through foreign intermediate goods from other industries, and that the elasticity of TFP with respect to foreign inter-industry technology effect is even close to ten percent. However, as it was assumed that foreign technology embedded in goods takes time to influence the productivity of the technology-importing country, the author decided to use the result from the specification with lagged foreign technology (equations 8 and 10 in Table 6). This is to say that foreign technology inflow of high tech commodities from the same sector matters for the productivity of Polish manufacturing industries.

Having stated this, the attention is now put on the examination of Polish exports, to check whether imports of high-tech commodities not only improve productivity but also allow for the development of industries that produce easily-imitable commodities.

Table 6. Domestic and imported technology stock

	Eq. 5	Eq.6	Eq.7	Eq.8	Eq.9	Eq.10
Same sector, total R&D in Poland	0.0450** (0.0112)	-0.0167 (0.0151)	-0.0377 (0.0234)	-0.0406* (0.0205)	-0.0371 (0.0230)	-0.0399* (0.0204)
Other sector, total R&D in Poland		0.0829** (0.0296)	0.0841** (0.0313)	0.0864** (0.0279)	0.0155 (0.0495)	0.0479 (0.0404)
Same sector, foreign R&D			0.0324 (0.0229)	0.0362* (0.0197)	0.0300 (0.0223)	0.0337* (0.0195)
Other sector, foreign R&D					0.0982* (0.0544)	0.0612 (0.0419)
Sector dummies	yes	No	No	No	No	No
Lagged foreign R&D	-	-	No	Yes	No	Yes
F-statistic (p-values)	-	3.8622 (0.0245)	3.4952 (0.0198)	5.2642 (0.0022)	3.1912 (0.0181)	4.2767 (0.0033)
Adjusted R^2	0.8214	0.0574	0.0908	0.1198	0.1046	0.1224
Number of observations	95	95	76	95	76	95

Notes:
(1) dependent variable = log of productivity index
(2) constant was included and was significant, but is not reported here
(3) heteroskedasticity-consistent standard errors in parentheses; ** and * indicate 5% and 10% significance, respectively
(4) lagged foreign R&D is the product of present import weight and foreign R&D stock, lagged by one year

Easily-imitable exports. Account and prospects

Given the state of the R&D sector in Poland, it is possible that high-tech imports can promote the development of the low-tech sector, as happened in some Asian countries. This hypothesis is of Chong and Zanforlin (2000), and can be verified by looking at exports flows. Chong and Zanforlin (2000) present an endogenous growth model where innovations created in a high-tech sector may be assimilated or adapted by a 'lower-tech' sector. This low-tech sector (consumer electronics, cars) expands and allows an economy to achieve long-run non-decreasing growth rates. This was actually the situation of Asian tigers with export-led growth. Chong and Zanforlin (2000) test their hypothesis on a sample of 79 countries for the period of 1960-1995, using dynamic panel data approach, and confirm their presumption.

The dynamics of 'low-tech' exports is analysed as follows. Two groups of low-tech manufacturing sectors are specified: the more narrowly and the more broadly specified easily-imitable sectors[7]. Then, the share of their exports in total exports and in manufacturing production is analysed. Not surprisingly, export of 'easily-imitable' technology intensive commodities has been gaining importance during 1994-2000, no matter how broadly specified.

[7] These two groups belong to the narrower and the broader 'easily imitable' categories, as specified by Chong and Zanforlin (2000: 25). They correspond to the following SITC categories: 714, 723, 725, 726 (narrow; office machines and some electrical machinery and equipment) and to 7 (broad; machines and transport equipment).

Table 7. Easily-imitable exports, 1994-2000

	1994	1995	1996	1997	1998	1999	2000	1999/1995*
narrowly defined group of industries:								
share in total manufacturing production	n.a.	0.0055	0.0061	0.0068	0.0083	0.0092	n.a.	0.6924
share in total exports	0.0225	0.0197	0.0226	0.0241	0.0283	0.0306	0.0291	0.5508
broadly defined group of industries:								
share in total manufacturing production	n.a.	0.0415	0.0440	0.0397	0.0573	0.0584	n.a.	0.4067
share in total exports	0.1420	0.1497	0.1630	0.1410	0.1944	0.1930	0.1901	0.2890

Note: * - percentage change
Source: own calculations based on data from Central Statistical Office and Ministry of the Economy

The importance of low-technology exports is growing faster when related to the manufacturing industry than to the whole economy (share in total exports). More narrowly defined easily-imitable export is also growing faster than its broader category. This means that the possibility of technological adaptation and export-led growth – of relatively low technological content – cannot be excluded. The hypothesis seems even more probable when we consider that this easy-to-imitate technology export account for nearly 20% of total exports and that it grew by 30% in five years.

Conclusions

The most important and robust finding of this research is that inflow of foreign technology matters for the productivity of domestic industries. The results of econometric testing suggest that there exist intra-industry spillovers deriving from imports of more technologically-advanced commodities to the same industry. The receiving industry benefits from foreign industries' technology, due to the trade in embodied technology. Technology, or know-how, created by foreign R&D investment is transmitted into domestic manufacturing industries, and enhances growth of domestic industries.

It is difficult to assess the influence of domestic technology stock on improvement of productivity of domestic industries. If something has an effect, then these are rather spillovers from R&D embedded in intermediates from other industries used in the production of a given industry. It can be interpreted that domestic investment in R&D has not started to be productive yet, and we still have to wait to see its effects. But it is also possible that business intramural R&D expenditures in Poland were targeted at other factors, not necessarily at productivity improvements.

The effects of FDI-related R&D stock are difficult to model. First of all, few foreign firms decide to conduct R&D in Poland, so the sample used for the estimations – and of course accumulated knowledge stocks – is small. Secondly, the results presented here, plus research on the subject, suggest that the relationship between the activities of multinationals and productivity growth is more complex, and the empirical evidence in economic literature on this issue is mixed.

It is possible, that given the productivity-increasing foreign technology inflows, Poland can benefit from further productivity improvements by the development of its low-tech sector. Starting from lower level of human capital than technological leaders, the economy can adapt through the use of know-how initially developed in the high-tech sector, along the lines of endogenous growth models with trade. In this view, imported technology helps to adapt and to develop the production of commodities that require a lower level of embodied technology, are labor-intensive, and relatively easy to produce. Broadly defined, lower-technology export of this type accounts for the significant part of Polish exports and has been growing continuously during the last years.

References

Angrist J. D., and Krueger A., B. (2001). Instrumental Variables and the Search for Identification: From Supply and Demand to Natural Experiments. *NBER Working Paper* No. 8456. September.

Barro, R. J., and Sala-i-Martin, X. (1995). *Economic growth*. MIT Press: Cambridge, Mass.

Bernard, A. B., and C. I. Jones (1996). Comparing Apples to Oranges: Productivity Convergence and Measurement across Industries and Countries. *American Economic Review* Vol. 86, pp. 1216-38.

Borensztein, E., De Gregorio, J., Lee, J.-W. (1995). How Does Foreign Direct Investment Affect Economic Growth? *NBER Working Paper* No. 5057.

Botazzi, L., and G. Peri (1999). Innovation, Demand and Knowledge Spillovers: Theory and Evidence from European Regions. *CEPR Working Paper* No. 2279.

Blomstrom, M. (1991). Host Country Benefits of Foreign Investment. *NBER Working Paper* No. 3615.

Blomstrom, M., Wolf, E. (1989). Multinational Corporations and Productivity Convergence in Mexico. *NBER Working Paper* No. 3141.

Branstetter, L. (2000). Is Foreign Direct Investment A Channel of Knowledge Spillovers? Evidence From Japan's FDI in the United States. *NBER Working Paper* No. 8015.

Caselli, F., Coleman, W. J. (2001). Cross-Country Technology Diffusion: The Case of Computers. *NBER Working Paper* No. 8130.

Chong, A. and L. Zanforlin (2000). Technological Adaptation, Trade, and Growth. *IMF Working Paper* No. WP/00/161.

Coe, D. T., and E. Helpman (1995). International R&D Spillovers. *European Economic Review*, No. 39, pp. 859-887

Dhose, D. (1996). The Transmission of Knowledge Spillovers and its Impact on Regional Economic Growth. *Kiel Working Paper* No. 774.

Djankov, S. and B. Hoekman (2000). Foreign Investment and Productivity Growth in Czech Enterprises. *World Bank Economic Review* Vol. 14, pp 49-64

Eaton, J. and Kortum, S. (1997). Technology and Bilateral Trade. *NBER Working Paper* No. 6253.

Ethier, W. J. (1982). National and International Returns to Scale in the Modern Theory of International Trade. *American Economic Review* Vol. 72, p. 389-405.

Feenstra, R. (1996). Trade and Uneven Growth. *Journal of Development Economics* Vol. 49, pp. 229-256.

Görg, H. and E. Strobl (2001). Multinational Companies and Productivity Spillovers: A Meta Analysis. *Economic Journal*, Vol. 111, No. 475, pp. F723-F739.

Griliches, Z. (1995). R&D and Productivity: Econometric Results and Measurement Issues. In: P. Stoneman (ed.), *Handbook of Economics of Innovation and Technological Change*. Blackwell, Oxford, pp. 52-89.

Grossman, G., and E. Helpman (1991). *Innovation and Growth in the World Economy*. Cambridge, MA: MIT Press.

GUS (2001). *Science and Technology in Poland in 1999*. Polish Central Statistical Office (GUS), Warsaw.

Keller, W. (2001). The Geography and Channels of Diffusion at The World Technology Frontier. *NBER Working Paper* No. 8150.

Keller, W. (2000). Geographic Localization of International Technology Diffusion. *NBER Working Paper* No. 7509.

Keller, W. (1999). How Trade Patterns and Technology Flows Affect Productivity Growth. *NBER Working Paper* No. 6990.

Keller, W. (1997). Trade and The Transmission of Technology. *NBER Working Paper* No. 6113.

Kinoshita Y. (2000). R&D and Technology Spillovers via FDI: Innovation and Absorptive Capacity. *CERGE-EI Working Paper* No.163. November.

Kinoshita Y. (1998). Technology Spillovers through Foreign Direct Investment. *CERGE-EI Working Paper* No. 139. December.

Krugman, P. (1979). A Model of Innovation, Technology Transfer, and the World Distribution of Income. *Journal of Political Economy* Vol. 87(2), pp. 253-66.

Nadiri, M. I., and S. Kim (1996). International R&D Spillovers, Trade and Productivity in Major OECD Countries, NBER Working Paper No. 5801.

Neven (1994). Trade Liberalization with Eastern Nations. How Sensitive? *CEPR Discussion Paper* No. 1000. July.

OECD (2000). *Main Science and Technology Indicators*. OECD, Paris.

Romer, P. M. (1990). Endogenous Technological Change. *Journal of Political Economy*. Vol. 98, p. 71-102.

Appendix I. Description of variables used in regressions

Data that are used in this research come from four different databases. The *OECD* database on research and development was combined with two Polish databases on industry and one on international trade.

The R&D expenditures of the leading *OECD* economies come from the ANBERD (Analytical Business Enterprise Research and Development) *OECD* database. The series that are used are business enterprise expenditures on R&D expressed in PPP adjusted constant US dollars[8]. The economies, that are considered as sources of high-technology imports were chosen among the group of countries that generates vast majority of the world R&D[9].

The flows of business R&D spending for industrial sectors in Germany, Italy, France, the Netherlands, Sweden, the UK, Japan, and in the US were used to calculate technology stocks for these countries. Following Keller (1997), R&D flows (φ_t*'s)* were cumulated using the perpetual inventory method, where the technology stock for each industry at time *t* equals:

$n_t = (1-\delta)n_{t-1} + \varphi_{t-1}$, for $t = 2, \ldots, 12$

and $n_1 = \varphi_1 / (\lambda+\delta+0.1)$.

The rate of depreciation of the knowledge stock - δ - is set at 0.1. This is a commonly used assumption in the literature on the subject. It is possible that the rate of depreciation of the knowledge stock is higher, thus reducing its rate of growth. Keller (1997) refers to two empirical papers, where the estimated value of δ is of the magnitude 0.12 and 0.25. Nevertheless, the author of this paper decided to adopt the assumption of 0.1 depreciation of the knowledge stock. The initial magnitude of the knowledge stock depends also on λ. This is the average annual growth rate of φ over the whole considered period. The denominator is increased by 0.1 in order to get rid of negative numbers of n_1.

The start year for the calculations of the technology stocks was set to 1987 and the end-year to 1998, primarily because of data constraints[10]. The *OECD* ANBERD data already consists of estimates as well as reported figures. In addition to this, some other missing data had to be interpolated by the author.

Technology stocks for Polish manufacturing industries were calculated with the use of the similar method as above. Flows of R&D business enterprise expenditures obtained form the *Polish Central Statistical Office (GUS)* were used to calculate stocks using the perpetual inventory method. The difference was in the knowledge depreciation rates and in the period over which the calculations were done. The parameter δ was set at 0.05 that is half the value used for the calculations of knowledge stocks for leading economies. The underlying assumption is that knowledge depreciates substantially slower in CEEs than in rich, Western

[8] PPP USD series were converted to constant 1996 US dollars using US GDP deflator.
[9] Further explanations about the choice of high-tech import sources are given in the Appendix.
[10] The ANBERD data on R&D for the majority of the countries of interest are given from 1987 onwards in ISIC Rev.3 classification. The oldest data are in the ISIC Rev.2 classification which is not easily comparable with the current one.

economies. The starting year for Polish data had to be 1995 (earlier data are not obtainable[11]), and the end year 2000. However, for the purpose of the econometric estimations outlined in the previous section, the period of analysis had to be reduced to 1995-1999, *i.e.* to only 5 years. The R&D expenditures were converted from the local currency to constant PPP adjusted US dollars with the use of the *OECD* GDP conversion rates and *IFS* US GDP deflators. They were also regrouped according to the ISIC Rev.3 classification, from the initial NACE Rev.1.

Foreign technology effect $b^f_{i,t}$ was obtained by multiplying technology stock indicator $n_{i,t}$ by the respective country's imports share in a given industry's imports. Polish trade statistics with detailed data on imports and exports of individual trading partners[12] are classified according to the *Combined Nomenclature* products database. In order to get the respective trade shares, trade nomenclature was correlated with the STIC Rev. 3 classification of economic activity. This operation required disaggregating trade data to a very low 8-digit level – *i.e.* to the level of individual products – in order to group them into the STIC 3-digit level of economic activity.

Recall that in the theoretical model the effective, domestic R&D stock that influences productivity of an industry is a sum of the own-industry R&D and other-industries R&D effect. And that this other-industries effect (b^{io}_j) is an input-output weighted stock of R&D efforts undertaken in other sectors of the economy. Polish input-output matrix for the manufacturing industries for the year 1998 is used in the construction of weights for respective industries. The input-output relations used here are given in the Appendix II.

Productivity indices are calculated in the usual way, that is:

$$ln(TFP_{i,t}) = ln(va_{i,t}) - \alpha_l \, ln(k_{i,t}) - \alpha_k \, ln(l_{i,t})$$

Where $va_{i,t}$ is value added, and $l_{i,t}$ and $k_{i,t}$ are the labour and capital inputs, respectively. Productivity growth is calculated as the difference between total output and total input growth:

$$\ln\left(\frac{TFP_{i,t}}{TFP_{i,t-1}}\right) = \ln\left(\frac{va_{i,t}}{va_{i,t-1}}\right) + \alpha_{i,t}\ln(l_{i,t}) + (1-\alpha_{i,t})\ln(k_{i,t}) - \alpha_{i,t-1}\ln(l_{i,t-1}) - (1-\alpha_{i,t-1})\ln(k_{i,t-1})$$

Value added of an industry is the sum of production revenues and value of inventories less total costs. Labour share in production, $\alpha_{i,t}$, is revenue-based, expressed as a ratio of total labour compensation to value added.

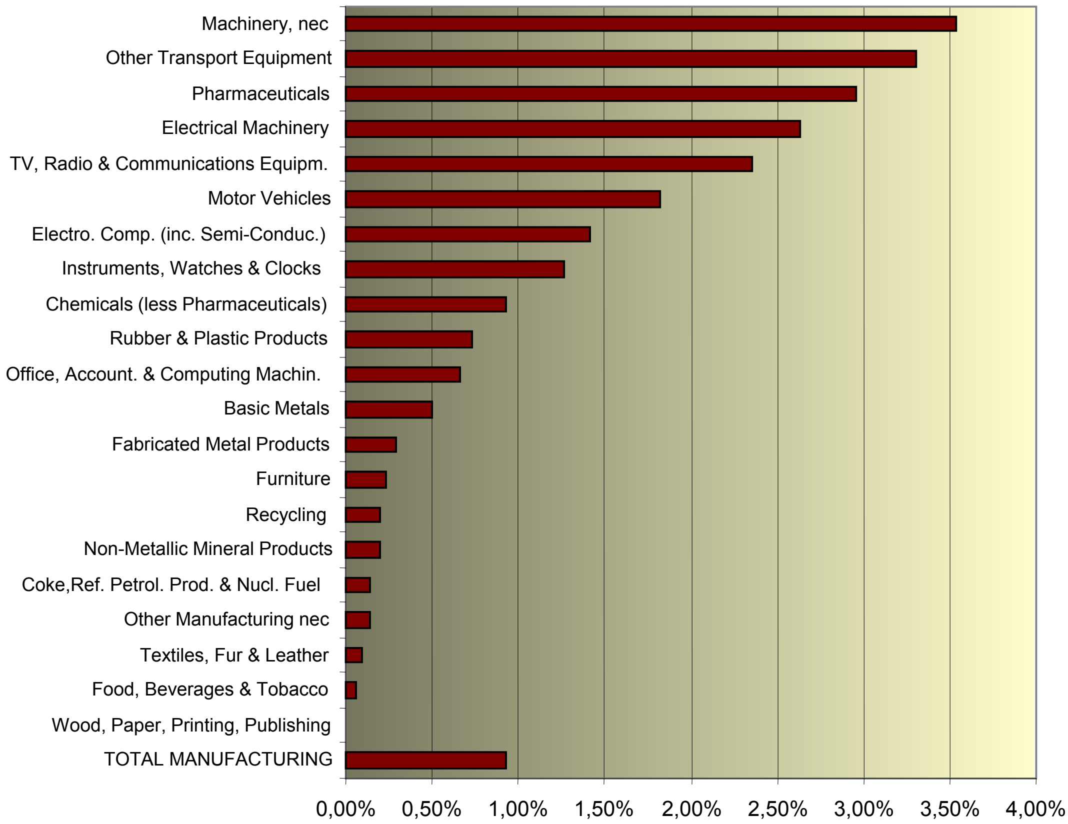
The numbers on capital stock can be obtained either by calculating stocks with the use of perpetual inventory method and data on investment flows and data or assumptions on depreciation rates, or simply by deflating value of capital reported by industries in their income statements. The author decided to follow the second approach. Data on capital stock are taken from *GUS*. This is the value of fixed assets less depreciation, deflated with the use of production deflators. This approach allowed calculating effective depreciation rates for

[11] There was a change in the statistical industrial classification in 1994, so earlier data are not comparable. Besides, there is only few data on business expenditures on R&D in 1994, since only few enterprises were reporting it, so the year 1994 had to be excluded from the analysis as well.
[12] The countries analyzed are the following: Germany, Italy, France, the Netherlands, Sweden, the UK, Japan, and the US.

Polish industries. On average, capital depreciated by 5.5% in Polish manufacturing sector during 1994-1999.

Appendix II. Issues related to construction or choice of variables

Figure 2. R&D intensity (R&D expenditures/VA) in Poland, 1999



Source: own calculations made on the basis of GUS (Polish Central Statistical Office) data

Choice of high-tech import sources

The author had to undertake the decision which trading partners should be considered as the technology-intensive import sources, as the analysis requires calculations based on the bilateral trade flows. It was assumed that the only technology-abundant countries from which

Table 8. Geographical structure of Polish imports, 1999

EU countries	65.5%
Germany	25.2%
Italy	9.4%
The Netherlands	3.7%
France	6.8%
CEFTA	6.7%
Former Soviet Union	7.7%
Developing countries	11.7%
Other	8.4%

Source: Poland's Report. Foreign Trade in 1999 (Ministry of Economy, 2000).

Poland may import high-tech commodities are the following: France, Germany, Italy, Japan, the Netherlands, Sweden, the UK and the US. The choice was motivated both by the high proportion of world R&D generated by these economies, the availability of OECD *ANABERD* data and their high relative import shares (see Table 8). Poland imports from these countries mainly technologically advanced commodities. For instance, around 70% of imports from the EU in 1999 belonged to two categories: manufacture of machinery and equipment and to the chemical industry, which are considered to be technology-intensive.

Table 9. Input-output relations for Polish manufacturing industry (percent of intermediate inputs of column industry going to the row industry in this industry's output), 1998

	ISIC Rev.3	15+16	17...19	20...22	23	24-2423	2423	25	26	27	28	29	30	31	32	33	34	35	361	369
Food, Beverages & Tobacco	15+16	0.000	0.007	0.031	0.008	0.013	0.013	0.016	0.004	0.001	0.006	0.007	0.000	0.001	0.000	0.000	0.001	0.000	0.000	0.000
Textiles, Fur & Leather	17...19	0.014	0.000	0.010	0.006	0.076	0.076	0.024	0.003	0.001	0.005	0.006	0.000	0.001	0.000	0.000	0.001	0.002	0.002	0.002
Wood, Paper, Printing, Publishing	20...22	0.002	0.002	0.000	0.006	0.033	0.033	0.010	0.006	0.002	0.013	0.010	0.000	0.002	0.001	0.000	0.001	0.002	0.003	0.003
Coke,Ref. Petrol. Prod. & Nucl. Fuel	23	0.005	0.000	0.002	0.000	0.035	0.035	0.010	0.001	0.001	0.008	0.011	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Chemicals (less Pharmaceuticals)	24-2423	0.009	0.015	0.010	0.024	0.000	0.230	0.042	0.002	0.004	0.005	0.005	0.001	0.002	0.000	0.002	0.000	0.000	0.001	0.001
Pharmaceuticals	2423	0.009	0.015	0.010	0.024	0.230	0.000	0.042	0.002	0.004	0.005	0.005	0.001	0.002	0.000	0.002	0.000	0.000	0.001	0.001
Rubber & Plastic Products	25	0.001	0.025	0.008	0.005	0.296	0.296	0.000	0.016	0.003	0.022	0.007	0.000	0.006	0.002	0.001	0.001	0.001	0.002	0.002
Non-Metallic Mineral Products	26	0.001	0.008	0.022	0.046	0.067	0.067	0.036	0.000	0.028	0.011	0.028	0.000	0.004	0.001	0.001	0.002	0.001	0.001	0.001
Basic Metals	27	0.001	0.004	0.002	0.058	0.050	0.050	0.041	0.015	0.000	0.027	0.031	0.000	0.003	0.001	0.001	0.001	0.000	0.000	0.000
Fabricated Metal Products	28	0.000	0.002	0.007	0.016	0.075	0.075	0.022	0.025	0.177	0.000	0.039	0.000	0.004	0.001	0.001	0.003	0.002	0.002	0.002
Machinery, nec	29	0.001	0.003	0.009	0.009	0.030	0.030	0.044	0.008	0.088	0.081	0.000	0.002	0.028	0.008	0.006	0.009	0.002	0.001	0.001
Office, Account. & Computing Machin.	30	0.000	0.008	0.004	0.001	0.002	0.002	0.007	0.000	0.038	0.015	0.005	0.000	0.091	0.019	0.058	0.001	0.009	0.015	0.015
Electrical Machinery	31	0.000	0.003	0.014	0.008	0.072	0.072	0.059	0.005	0.141	0.044	0.031	0.005	0.000	0.016	0.015	0.002	0.001	0.002	0.002
Electro. Equip.(Radio, TV & Commun.)	32	0.000	0.001	0.007	0.005	0.015	0.015	0.013	0.010	0.017	0.009	0.006	0.024	0.143	0.000	0.031	0.003	0.002	0.002	0.002
Instruments, Watches & Clocks	33	0.000	0.002	0.009	0.003	0.027	0.027	0.017	0.006	0.041	0.044	0.019	0.006	0.041	0.009	0.000	0.002	0.010	0.015	0.015
Motor Vehicles	34	0.000	0.006	0.008	0.006	0.069	0.069	0.051	0.004	0.073	0.033	0.107	0.001	0.013	0.004	0.003	0.000	0.004	0.001	0.001
Other Transport Equipment	35	0.000	0.007	0.007	0.008	0.034	0.034	0.017	0.005	0.087	0.032	0.120	0.002	0.033	0.009	0.007	0.015	0.000	0.002	0.002
Furniture	361	0.001	0.071	0.162	0.007	0.041	0.041	0.057	0.015	0.044	0.032	0.007	0.000	0.003	0.001	0.001	0.002	0.012	0.000	0.019
Other Manufacturing nec	369	0.001	0.071	0.162	0.007	0.041	0.041	0.057	0.015	0.044	0.032	0.007	0.000	0.003	0.001	0.001	0.002	0.012	0.019	0.000

Source: own calculations on the basis of data from GUS (Polish Central Statistical Office)

Table 10. Import weights by country and by industry, average for 1994-1999

Description	ISIC Rev.3	US	Japan	Germany	France	UK	Italy	Sweden	Netherlands
Food, Beverages & Tobacco	15+16	0.028	0.000	0.192	0.029	0.022	0.019	0.010	0.102
Textiles, Fur & Leather	17...19	0.013	0.004	0.322	0.026	0.010	0.110	0.003	0.035
Wood, Paper, Printing, Publishing	20...22	0.020	0.000	0.279	0.022	0.025	0.036	0.071	0.027
Coke,Ref. Petrol. Prod. & Nucl. Fuel	23	0.007	0.000	0.148	0.016	0.128	0.001	0.152	0.029
Chemicals (less Pharmaceuticals)	24-2423	0.026	0.011	0.268	0.062	0.044	0.030	0.010	0.049
Pharmaceuticals	2423	0.051	0.004	0.172	0.139	0.084	0.081	0.015	0.047
Rubber & Plastic Products	25	0.016	0.001	0.340	0.035	0.045	0.102	0.013	0.025
Non-Metallic Mineral Products	26	0.013	0.010	0.201	0.069	0.012	0.135	0.016	0.014
Basic Metals	27	0.001	0.000	0.196	0.027	0.013	0.057	0.030	0.009
Fabricated Metal Products	28	0.009	0.000	0.350	0.026	0.013	0.121	0.030	0.016
Machinery, nec	29	0.027	0.013	0.347	0.033	0.028	0.154	0.022	0.017
Office, Account. & Computing Machin.	30	0.130	0.077	0.087	0.026	0.116	0.029	0.001	0.023
Electrical Machinery	31	0.025	0.012	0.326	0.055	0.023	0.079	0.014	0.049
Electro. Equip.(Radio, TV & Commun.)	32	0.065	0.050	0.115	0.074	0.069	0.024	0.034	0.021
Instruments, Watches & Clocks	33	0.107	0.065	0.233	0.019	0.024	0.056	0.011	0.014
Motor Vehicles	34	0.005	0.025	0.269	0.108	0.055	0.163	0.051	0.015
Other Transport Equipment	35	0.149	0.008	0.138	0.009	0.005	0.244	0.001	0.001
Furniture	361	0.000	0.000	0.235	0.032	0.020	0.228	0.020	0.000
Other Manufacturing nec	369	0.001	0.029	0.064	0.014	0.013	0.074	0.000	0.008

Source: own calculations on the basis of data from Ministry of the Economy