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Impact of FDI on technology transfers and innovations' creation in the Polish economy

1. General remarks

The opening of the Polish economy through the liberalization of foreign trade and liberalization of rules concerning the foreign capital inflows implies that domestic production has become increasingly dependent on foreign technology.

One of the aims of the research undertaken in the framework of INCO Copernicus Projects was to analyse the domestic and foreign embodiment of RTD expenditures in each industry of the Polish economy. On the basis of domestic and foreign technological content we have been trying to formulate some more general assumptions on the sectoral technological development and restructuring of the Polish economy.

In this paper we present the stage of investigations, which concerns the analysis of FDI inflows and RTD expenditures¹ in Poland. We also briefly characterize the methodological approach which can be used in the estimation of foreign embodiment of RTD through direct investments.

Let us start with the characteristics of economic environment, institutional and legal rules in which the process of FDI inflows started. The transformation of the Polish economy opened it to the foreign capital, however, as it is commonly believed this opening process has had several stages till now.

¹ RTD expenditures are understood here as expenditures on R&D and innovation activity.

A limited opening of the Polish economy to foreign capital inflows was introduced in the eighties, however, the first wave of acceleration of foreign capital inflows was observed after 1988 (1989-1991), when the Polish law relaxed the conditions for foreign investors. The scale of foreign direct investment was not significant in this period as there still existed formal constraints (complicated legislation procedures, constraints imposed on profit repatriation and invested capital scale, obligatory sales of foreign currency at the fixed exchange rate to the National Bank). The enterprises with foreign capital had, however, tax holidays depending on the exports level. Thus, the foreign investor strategy was rather short-term oriented at high exports and strong profitability and adapted to those entrepreneurs who could utilize profits in Poland, as profits transfers were constrained (they were mostly of Polish origin persons). In this period technology transfer was mainly realised by purchases of licenses, joint ventures and subcontracting.

In February 1991 the relaxation of investment regulations for foreign investors was introduced. Practically all the restrictions concerning profit transfers, the level of invested capital and setting up of enterprises were removed. At the same time tax holidays were also liquidated. The second acceleration of FDI inflows which started in 1992 was connected, however, not only with introduction of the new law but, first of all, with the economic recovery. It brought new quality in the process of FDI flows and consequently new forms and levels of technology transfers. Buying privatised enterprises and setting up new ones the foreign investors transferred their technology to Poland. In value terms the superiority of foreign investors participating in the capital privatisation is evident and permanently growing.

Recent years witnessed a rapid growth in foreign direct investment in Poland. The term 'rapid' primarily means high dynamics of the phenomenon, that reached or even exceeded 100 per cent in some years. Yet, the extent of these investments in the economy only starts being significant, taking into account the possible absorption and needs of the Polish economy.

2. FDI – level and structure

2.1. Main figures

There are, at least three sources of information on foreign investors in Poland: (1) GUS (Central Statistical Office) data on companies with foreign participation (balance-sheet reports), (2) NBP statistics (Polish National Bank) on yearly net values of foreign direct investment (purchases of shares, credits granted by foreign investors, re-invested profits), and (3) PAIZ (Polish Agency

for Foreign Investments) register of major foreign investors (above \$1 million worth of equity).

In this paper we mostly use the PAIZ statistics. According to these data the cumulative value of FDI in 1998 exceeded \$ 27 billion (see Table 1) and adding estimated value of FDI below 1 mln \$ it reached \$ 30.7 billion (see Table 2). The net value in 1998 amounted to a record-high level of \$ 10,0 billion (according to NBP - \$ 6,3 billion). A steady inflow of FDI was observed in the first half of 1999 – nearly \$ 5 billion. The data about the largest companies (where foreign capital exceeds \$ 1 million) indicate that the process of capital concentration is continued. In 1997 large companies constituted only 6% of the total number of companies with foreign participation whereas their FDI share was about 90%.

The order of dominant investors was slightly changed in 1999 but still the list is opened by German investors (19%, 171 firms) followed by investors from the USA (15.6%, 119) and from Italy (10%, 67). In the first half of 1999 (as in the previous two years) around 90% of FDI came from OECD countries (\$24,3 billion in 1998, \$28,7 in the first half of 1999). According to PAIZ data the European Union countries invested till the first half of 1999 \$15 billion - 47% of total, till 1998 - 43% of total, North American investors - 16% till the first half of 1999, till 1998 - 18% whereas the share of Asian countries was as follows: 6% in 1998 and 5.4% in 1999.

In the tables below we show that the rapid growth of FDI inflows to Poland, especially in 1998, was a result of both an increase of capital of firms operating in the Polish market and investments in new firms. In 1998 (see Table 3) the largest foreign investor was Russian RAO Gazprom (\$938 million invested in construction of the Yamal - Western Europe gas pipeline) and German Hypo-Vereinsbank (\$604 million paid for shares of Bank Przemysłowo-Handlowy).

By the end of June 1999 three other important investors should be pointed out: Dutch United Pan-Europe Communications with \$1.150 million invested in the media and entertainment sector, UniCredito Italiano with \$1.045,3 million invested in the purchase of shares of Bank PKO S.A. and Allied Irish Bank with \$746,7 (\$582 million spent on the purchase of 80% of Bank Zachodni shares).

At the end of 1998, the largest share of FDI was in the manufacturing sector (58,3% of the total). On the top of the list within the manufacturing sector there were industries producing food, beverages and tobacco (28%), transport equipment (22.8%), paper publishing and printing (8.5%), chemicals (8%) electrical and optical equipment (6.4%). The same order is observed in the first half of 1999.

Table 1. Foreign Direct Investment in Poland - countries of origin

Country	1997		1998		1999 (first half)	
	Capital invested (millions of USD)	Number of investors	Capital invested (millions of USD)	Number of investors	Capital invested (millions of USD)	Number of investors
Germany	2104,9	134	5117,3	163	6073,9	171
USA	3981,8	91	4911,2	112	5006,9	119
France	1616,4	51	2398,9	60	2562,8	63
Italy	1636,3	44	2037,6	64	3145,6	67
Sweden	565,8	36	691,5	37	736,7	39
Austria	660,3	34	758,3	31	768,1	30
Netherlands	1213,6	34	1878,9	42	3083,9	45
Great Britain	1002,0	26	1929,5	28	1994,8	32
Denmark	306,8	22	558,4	28	508,1	29
Canada	94,8	19	235,6	21	238,5	22
Belgium	115,2	15	156,8	19	281,1	20
International	1654,0	15	1813,1	18	1886,6	17
Finland	137,9	11	191,2	16	200,0	17
Switzerland	445,3	9	666,2	13	598,9	14
Japan	69,5	8	198,3	11	232,9	11
Norway	240,0	7	455,8	12	451,1	11
South Korea	1077,8	5	1412,4	4	1449,8	4
Australia	354,1	4	98,1	4	98,1	4
Liechtenstein	12,3	4	29,5	3	29,5	3
Ireland	191,2	3	226,1	3	813,7	3
Greece	23,0	2	3,6	2	1,5	1
Turkey	3,6	2	48,0	2	50,1	3
China	25,0	1	25,0	1	45,0	2
Croatia	100,0	1	138,0	1	138,0	1
Czech Republic	2,5	1	68,4	4	67,7	4
Slovenia	6,0	1	6,0	1	6,0	1
Luxembourg	2,3	1	2,3	1	11,6	2
Rep. of South Africa	25,0	1	25,0	1	25,0	1
Russia	20,0	1	958,0	1	1112,2	2
Singapore	13,0	1	-	-	-	-
Spain	5,0	1	62,3	3	62,3	3
Israel	0	0	5,4	3	5,4	3
Hong Kong	0	0	20,0	1	-	-
Portugal	0	0	147,2	3	286,8	3
Taiwan	0	0	5,7	1	5,7	1
Cyprus	-	-	-	-	4,1	1
Malaysia	-	-	-	-	6,4	1
Total	17705,4	585	27279,6	714	31988,7	750

Source: PAIZ data on FDI (above 1 million worth of equity).

Financial intermediation - the second NACE section attracted the largest amount of foreign capital (17.6% of total in 1998). It was followed by trade and repair sector (10.8%) and construction (6.2%). The first half of 1999 did not bring any significant changes in this order, however, the municipal and personal services enjoy a growing interest of foreign investors.

Table 2. Foreign Direct Investment in Poland - breakdown by activity

Activities according to the European Classification of Activities (ECA)	1997	1998	1999 (the first half)
Manufacturing	11148,6	15912,1	16419,3
of which:			
- food, drinks, tobacco products	3216,2	4460,7	4564,3
- transport equipment	2390,1	3627,9	3962,2
- products of other non-metal materials of which:	934,8	2576,8	1924,1
- wood and wooden products	16,2	392,2	240,0
- fabrics and textiles	207,9	226,1	244,9
- pulp and paper, printing and publishing	1058,5	1353,9	1359,3
- chemicals and chemical products	1106,7	1272,4	1291,2
- electrical machinery	1382,3	1016,3	1199,4
- other machinery and equipment		584,8	461,2
- rubber and plastics	359,1	422,7	444,2
- metals and metal products	377,1	354,2	366,8
- other goods	99,7	242,4	728,5
Financial intermediation	3096,4	4802,9	7185,4
Wholesale and retail trade, repair	1285,8	2942,7	2460,8
Construction	704,5	1685,3	1172,1
Transport, storage, communication	579,0	719,3	734,9
Hotels and restaurants	245,7	429,8	414,9
Community, social and personal services	312,3	397,8	1508,3
Power, gas and water supply	204,5	241,8	476,8
Real estate, renting and business activities	62,4	112,0	126,0
Agriculture	22,0	24,1	30,1
Quarrying and mining	44,2	11,8	61,8
Total foreign direct investment over 1 mln USD	17705,4	27279,6	31988,7
Estimated value of FDI below 1 mln USD	2882,3	3371,6	3518,8
Total FDI in Poland	20587,7	30651,2	35507,5
FDI/GDP*	4,6	6,4	
FDI/total investments*	19,4	25,5	

Source: PAIZ data incl. projects worth below \$ 1 million;

* Estimations²

² Chojna J. (1999), The Role of Companies with Foreign Participation in Poland's National Economy, In: *Foreign Investments in Poland*, Foreign Trade Research Institute, Warsaw, p.27 (in Polish).

Table 3. Major foreign investors in Poland in 1998 (net value)

Investor	Equity and loans (\$ million)	Country of origin	Branch
RAO Gazprom	938	Russia	Construction
HypoVereinsbank	604	Germany	Banking
Metro AG	398	Germany	Trade
Daewoo	337	South Korea	Automotive industry, electronics, construction
Harbin	326	Netherlands	Breweries
Opel	260	Germany	Automotive industry
Glaxo Wellcome	220	United Kingdom	Pharmaceuticals
Fiat	215	Italy	Automotive industry
Commerzbank	179	Germany	Banking
Aral	173	Germany	Filling stations

Source: PAIZ data.

**Table 4. Major foreign investors in Poland in first half 1999
(cumulative value)**

Investor	Equity and loans (\$ million)	Country of origin	Branch
Fiat	1405,2	Italy	Automotive industry, banking, insurance
Daewoo	1385,8	Korea	Automotive, electrical machinery and equipment, construction, insurance
United Pan-Europe Communications	1150,0	Netherlands	Media and entertainment
RAO Gazprom	1108,6	Russia	Construction
UniCredito Italiano	1045,3	Italy	Banking
Bayerische Hypo-und Vereinsbank AG	1000,0	Germany	Banking
Allied Irish Bank Plc	746,7	Ireland	Banking
EBRD	703,4	International	Banking, capital investment
Metro AG	598,0	Germany	Wholesale and retail trade
Polish-American Enterprise Fund	505,0	USA	Capital investment

Source: PAIZ data.

2.2. Transfer of new technologies and impact of FDI on development of the Polish economy

The impact of foreign capital is usually considered in several areas, which are often interrelated. On the basis of several analyses³ we made a list of the most frequently analysed questions of macroeconomic impact. They include:

- transfer of new technologies and creation of innovations,
- efficiency of use of production factors,
- level of employment,
- impact on foreign trade and on balance of payments,
- GDP growth and economy's development.

According to the problems investigated under the Project INCO-COPERNICUS we pay attention to the technology and innovations' creation and to the two next interrelated questions of the above list. However we also contributed to the project the conference paper⁴ devoted to foreign trade and economic growth of the Polish economy in the context of FDI and technology inflows.

Basing on research made by Foreign Trade Research Institute⁵ we give below a short report on main economic categories of companies with foreign participation.

2.2.1. Investment and equity, efficiency of use of production factors

According to investigations based on the GUS balance-sheet data the largest percentages of companies with foreign participation were engaged in 1997 in commercial activities (trade - 35%, real estate and business - 34%). The average value of foreign assets invested in one company was in 1997 2,8 million PLN in industry, 1,3 million PLN in trade, 1,4 million in real estate and business activity.

³ See, among others: Witkowska J. (1996), *Foreign Direct Investments in Central-Eastern Europe* University of Lodz (in Polish); *Foreign Investments in Poland* (1995), (ed. By Foreign Trade Institute and Polish Agency for Foreign Investments), Warsaw; Misala J. (1996), *The Role of Foreign Capital in Creation and Development of the Market Economy in Poland* Main School of Trade, Warsaw (in Polish).

⁴ M. Przybyliński, Ł. Tomaszewicz, *FDI and Structural Change in Poland*. Paper presented at the EAEP Conference in Prague, November 1999.

⁵ *Foreign Investments in Poland*, Foreign Trade Research Institute, (1999), Warsaw 1999 (in Polish)

As the foreign capital concentration is considered, the highest share of total equity of all companies with foreign participation was recorded in 1997 by tobacco products companies (25 million PLN per company) whereas in firms producing food products and beverages accounted for the largest share of total equity of all companies with foreign participation. It was 5,1 million PLN on average, and motor vehicles companies -19 million PLN. The latter play the most significant role in industrial production in Poland. It is worth underlining that in 1997 as compared with 1996 a certain decline in number of companies could be noticed in food processing industry and a marked drop was observed in clothing and wood, as well as in publishing and printing industries⁶.

At the end of 1997 investment outlays of companies with foreign participation amounted to 24,5 billion PLN (40.2% of total investment in the economy). In many sections of the Polish business activity it was more than a half of total investment outlays (trade and repair, financial intermediation, manufacturing, construction). In these companies external capital plays a dominant role. In 1997 it constituted 66% of total capital whereas in 1996 it was 62%.

The financial standing of companies with foreign participation deteriorated in 1997 as compared with all economic entities and as compared with the previous years⁷. Positive profitability was recorded by only a half of these companies in 1997. The explanation of such a situation⁸ are growing inflows of FDI, which means that most of these companies are entering the stage of organization and reorganization as well as of intensive replacing of fixed assets.

2.2.2. Employment

Companies with foreign capital participation provided in 1997 12.5% of employment in economic entities filing balance-sheet reports and this level was higher than in previous years. Relatively low employment in firms with foreign capital participation - taking into account the overall position of foreign direct investors in the Polish economy - results from labour productivity being twice higher than average for the whole economy.

⁶ I. Zagoździńska (1999), Entities with Foreign Participation in Poland in 1997 (According to Data). In.: *Foreign Investments in Poland*, Foreign Trade research Institute, Warsaw 1999 (in Polish)

⁷ Chojna J. (1999), op. cit.

⁸ Chojna J. (1999), op. cit.

Table 5. Employment and employee incomes in companies with foreign capital participation by NACE sections in 1997

Specification	Share in total employment in the enterprise sector (%)	Employee incomes of companies with foreign participation - per employee incomes of all entities = 100%
Total: 1994	7,0	177
1995	10,1	165
1996	10,0	200
1997	12,5	180
By NACE section in 1997:		
Industry	15,0	174
Of which: manufacturing	18,2	185
Consumption	4,3	244
Trade and repair	11,5	196
Hotels and restaurants	13,1	209
Transport storage and communication	3,4	403
Real estate and business activities	9,1	257

Source: Chojna J. (1999), op. cit., p. 32 and 33.

As it can be seen from Table 6 employee incomes are much higher in companies with foreign capital participation than employee incomes counted for all entities; in 1997 they were almost twice higher on average. Employee incomes in particular branches were more differentiated, reaching four times higher level in transport, storage and communication.

2.2.3. Foreign trade and balance of payments

As it follows from the investigations of Foreign Trade Research Institute⁹ companies with foreign capital participation are more export-oriented than companies with exclusively Polish equity. It should be noted, however, that export activities of companies with foreign participation show a downward trend. The value of export intensity is much higher in companies with foreign participation (72% in 1997) than those without foreign participation also because the decline in the latter was much more pronounced.

⁹ Chojna J. (1999), op. cit.

The import-intensity of companies with foreign capital participation remains relatively high and is much higher than in companies with exclusively Polish equity, although import growth rates show a downward tendency in firms with foreign participation. High import-intensity results, first of all, from demand for capital goods (modernisation of production assets).

Table 6. Foreign trade characteristics of companies with foreign participation

Years	Shares (%)		Growth rates (%)				
			Companies with foreign participation		Overall growth		Shares in trade deficit
	Exports	Imports	Exports	Imports	Exports	Imports	
1997	43,0	49,9	34,0	34,7	5,4	13,9	60,7
1998	47,9	53,4	22,1	18,9	9,6	11,2	61,6

Source: on the basis - Durka B., Chojna J. (1999), Share of Companies with Foreign Participation in Polish Foreign Trade, *Foreign Investments in Poland*, Foreign Trade Research Institute, Warszawa (in Polish).

3. Technology transfer and innovations

3.1. Mechanisms of foreign investment inflows

From the above presented tables it follows that FDI firms consistently increase their investment in Poland. Their growth is higher than inflation.

No doubt the capital inflows is an important source of investments in Poland, i.e. in a country with a scarcity of capital. At the same time the opening of the Polish economy revealed a low competitiveness of protected sectors. In this situation FDI is one of the most effective channels of technology transfers and creation of innovations. New technologies come mostly from transnational companies, which are the source of majority of technological innovations and from Canadian, Austrian, British and American investors. There are two main branches in which they are installed - informatics and printing industries.

There should be also taken into account external (multiplier) effects of new technology and know-how transfers, namely modification of the economic environment in which local firms operate. Thus, technology transfer is understood not only as transmission of technology through machines, equipment

and organisational solutions but also as assimilation and spill-over effects (learning effects).

For countries coping with a technological gap, FDI inflows create a possibility of making the so-called frog-jump, i.e. to reach a higher technological level.

Of course, the efficiency of technology transfer depends also on absorption ability of a given country, being mainly a result of the economic policy adopted in this country. It was revealed that the policy encouraging export-oriented investors is a driving force in this case as competitiveness of export-oriented entities forces also other entities to apply modern technology.

The PAIZ investigations¹⁰ revealed that the majority of entities with foreign capital (62%) have technologies and equipment not more than one-year old. One-fourth of them use equipment not more than 10 years old. There is a growing number of entities with completely new technologies (less than 1 year old).

It is very important to answer the question about mechanisms of foreign investment inflows and development being a result of investors' motivations, as the types of FDI decide about the types of technology and innovation transfers to Poland.

These mechanisms are shortly characterized by Kubiela (1995)¹¹ as follows. According to the Ricardo model the investors's decisions are based on the comparative advantage of a given country. Thus, the factor which decides about their decisions are the cost of production (and the exchange rate). In this case FDI is located in these sectors in which production costs (especially, labour costs) are low. Typical forms of technology transfer in this case are purchases of licenses and subcontracting.

In the Keynesian type of FDI inflows the determinants are internal and external demand for products being a result of this investment. In this case the investment is located in sectors producing standard mass products fulfilling the internal demand at the first stage. During the second stage, the investment is located in sectors producing export-oriented products. According to the Keynesian mechanisms the investment is located mostly in sectors representing a medium technology level. Technology transfer through FDI is realised by

¹⁰ See among other: Garlicki J. (1996), New Technologies and Investment Growth, *Foreign markets* n. 61 (in Polish); Umiński S. (1998), Technology Transfer by Foreign Investors, In: Instruments and Tools of Technology Transfer and Government Innovation Policy, Agency of Technics and Technology, Warsaw (in Polish).

¹¹ Kubiela S t. (1995), Technology transfer in restructuring new market economies. The case of Poland, STEEP Seminar May.

purchases of new fixed assets and their modernisation as well as by greenfields investment.

According to the Schumpeter model FDI needs free circulation between countries. It increases absolute technological advantages through high dynamics of innovations. Such a model demands a high level of intangible assets as well as significant outlays on R&D. High technology levels are observed in sectors producing highly processed goods.

Technology transfer is a very difficult process for verification. In order to analyse this problem a questionnaire survey was made by the Center for European Union Integration Research of Gdańsk University¹². 88 entities representing firms with foreign capital participation and 77 firms with entirely Polish capital were surveyed. In both groups there were enterprises of different size and belonging to different sectors. In the first group there were only the representatives of EU investors, 75% of which invested after 1990, but mostly (45%) in the years 1990-1992. It means that the statistics do not include properly representatives of investors of the "third wave" started in the years of the Polish economy recovery (especially 1994-1997).

The investors asked about motives of their decision to invest in Poland mostly answered that the capacity of the Polish market (demand) and low costs of production (see the first and second model of FDI inflows mentioned above) were the reasons.

Technology introduced to Poland through FDI was compared with technology of foreign firms invested in Poland. More than 50% of analysed entities answered that their equipment was comparable with that of the parent company.

In the firms with foreign capital participation increasing share of new and modernised products was observed (62% of firms). Quality of products, modernity of machines and equipment was evidently higher in the analysed firms than in those with entirely Polish capital and as compared with the parameters the analysed firms had before FDI inflow.

The 88 surveyed enterprises were also analysed according to the level of R&D outlays. 30% of firms declared that they were carrying out R&D activity. The average outlays reached 4,3% of sales. The majority of outlays were made in the following sectors: transport vehicles, chemicals and energy, thus, i.e. in sectors having a big and absorptive market, which confirms a general opinion about propensity to innovation in the country of capital location. Learning effects in the firms with foreign capital participation in their most spectacular form were also observed, namely growth of qualifications and productivity of

¹² Umiński S. (1998), op. cit.

employers, growth of responsibility and improved command of foreign languages.

We would like to stress one important question, which was asked in the questionnaire, namely the estimation of creativity of new technologies. The answer gives some idea about the extent to which FDI brings modernity and technological advancement and to which extent it is an adaptation of technology existing earlier in foreign firms. More than a half of entities with foreign capital participation answered that the introduced technology had an applicable-innovative character and was modified according to Polish circumstances. It explains, to a certain extent, the fact that innovation activity of Polish companies (with more than 50% of foreign capital) is smaller than of enterprises with exclusively Polish capital as it follows from the investigation carried out by GUS¹³. From this investigation it also follows that large enterprises are more innovative than small and medium-sized ones. According to the PAIZ data the share of large enterprises (with FDI bigger than \$1 million) was only 6% in 1997. This is another explanation of a low share of innovating enterprises (28%) in the group of companies with foreign participation whereas in the whole set of public sector enterprises it was 50%, in the private sector – 30.3%¹⁴.

4. The RTD outlays in Poland under the transformation period

Some information on inputs on RTD can be obtained in the Polish statistical yearbooks of industry. There are also special publications devoted to R&D data¹⁵. Unfortunately, these sources do not give comparable data. The R&D data present the total R&D costs (current and investments), which are aggregated in this way that they are comparable with the definitions of international statistics in this area (UNESCO data basing on OECD methodology). However, these data are aggregated according to R&D institutions, not to branches and concern only the years 1990-1993 as transformation period is considered. The basis for these grouping were data published in industry statistical yearbooks. They needed, however, modification

¹³ Science and Technology in Poland (1997), GUS Warsaw (in Polish).

¹⁴ See GUS, Warsaw, op.cit.

¹⁵ Rejn B. (1994) Outlays of research and development institutions under transformation period, Institute of Economic and Statistical Research, Central Statistical Office, N.222 (in Polish), Rejn B. (1995) Outlays of research and development activity in Poland, Institute of Economic and Statistical Research, Central Statistical Office, N.228 (in Polish), see also above mentioned GUS publication.

of institutional grouping, of costs grouping definition and other modifications to make them comparable with international statistics.

In our investigation we use data from the statistical yearbooks as they give us possibility of branch analysis. To explain what kind of information this data supply we present their description given in statistical yearbooks. They are called "financial inputs on innovations (in older yearbooks - inputs on technical development) and comprise the outlays on research and development activities concerning

- launching production of new and modernised products (product innovations),
- application of new technologies and introduction and development of mechanization and automation (process innovations),
- introduction of technical and organizational innovations (others).

They also include the outlays on evaluation of licenses and patents and their purchasing and introduction, as well as expenditures on materials and equipment needed for the implementation of innovation projects.

As it was mentioned above the data presented here are not fully comparable with the aggregates of R&D expenditures published in B. Rejn (1994, 1995). From that publication it results, that in constant prices R&D expenditures were in 1991-1993 at the level of a half of those in 1988 (i.e. before the transformation). It can be also seen that in 1992 Poland's R & D expenditures per capita amounted to about USD 40 and among European countries they were similar to those in Greece and Turkey. In 1996 it was about USD 52 which was similar to that in Hungary and in Greece in 1993. As regards to GDP, Poland was placed at Spain's level (about 0,9%) before the above mentioned countries. According to our data in constant prices¹⁶ (see Table 7) the growth in analysed outlays has been observed in 1992 and 1993. It concerns especially those branches in which the analysed inputs were low: metallurgy, wood and paper and textile and cloth industry. Budgetary constraints brought about another decrease in several branches in 1995. Two of them (electro-engineering, wood and paper) belong to those in which FDI have the highest level.

¹⁶ My acknowledgements go to G. Juszcak-Szumacher who collected data and made the recalculation from current to constant prices (in an approximate way by applying of investment deflators in particular branches).

Table 7. Growth rates and industry structure of investment outlays(financial costs of R&D)¹⁷ (in %)

Year	tbrqf (1)	tbrqm (2)	tbrqe (3)	tbrqc (4)	tbrqs (5)	tbrqd (6)	tbrql (7)	tbrqr (8)	tbrqz (9)
1990	-27.4	-42.4	-32.6	45.9	-34.7	12.3	-34.9	-4.3	342.5
1991	68.0	-28.6	-38.3	-57.1	-20.1	-38.2	-85.8	103.1	-90.5
1992	96.3	570.3	68.5	222.1	17.3	665.3	937.7	10.1	129.9
1993	25.5	-11.5	69.1	93.6	132.6	68.7	61.8	43.2	-52.8
1994	-87.8	-87.2	-87.5	-93.9	-65.5	-89.3	-93.8	-88.6	-54.7
1995	28.0	46.5	-9.0	45.3	-26.7	-33.5	1.8	83.4	-19.4

Industry structure of outlays for R&D is differentiated with the smallest shares in total industrial outlays being recorded by textile and cloth, mineral and other industries (Table 8).

Table 8. Industry structure of R&D outlays

Year	ubrql (1)	ubrqm (2)	ubrql (3)	ubrql (4)	ubrql (5)	ubrql (6)	ubrql (7)	ubrql (8)	ubrql (9)
1990	0.069	0.050	0.469	0.150	0.037	0.044	0.030	0.092	0.059
1991	0.157	0.049	0.362	0.087	0.040	0.037	0.006	0.255	0.008
1992	0.137	0.145	0.285	0.125	0.021	0.127	0.027	0.125	0.008
1993	0.119	0.089	0.288	0.167	0.033	0.148	0.030	0.124	0.003
1994	0.134	0.105	0.256	0.094	0.107	0.146	0.017	0.130	0.011
1995	0.151	0.136	0.206	0.120	0.069	0.085	0.016	0.210	0.008

These data cannot be fully comparable with those published by GUS due to different methodologies of data collection and classifications.

¹⁷ Abbreviation of industries:

- 1) qf - fuel and energy,
- 2) qm - metallurgy,
- 3) qe - electro-engineering,
- 4) qc - chemical,
- 5) qs - mineral,
- 6) qd - wood and paper,
- 7) ql - textile and clothes,
- 8) qr - food-processing,
- 9) qz - other industries

tbr standing before industry name means growth rate

ubr standing before industry name means a share

In 1997 the highest shares of innovation outlays were recorded by motor vehicles, electromachinery and chemical industries.

Fig. 1. Innovation outlays by kinds in 1991

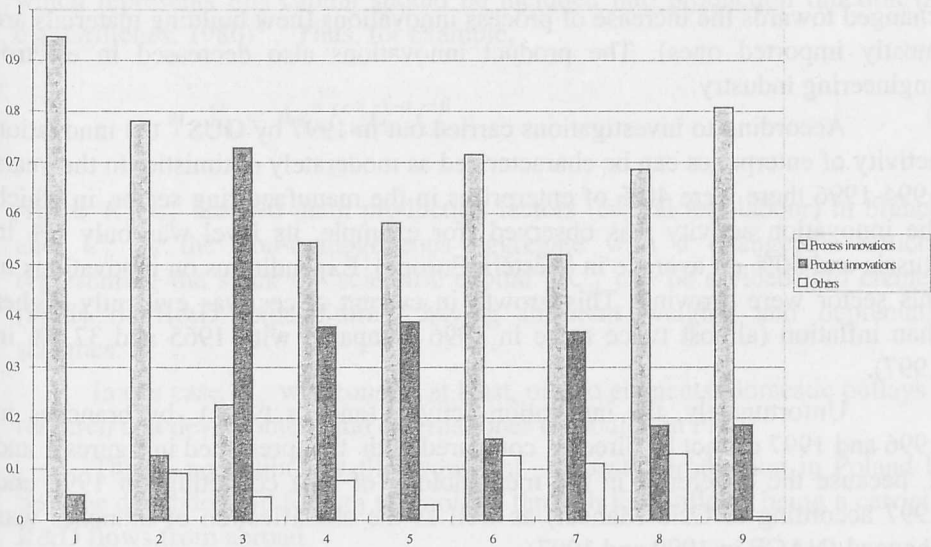
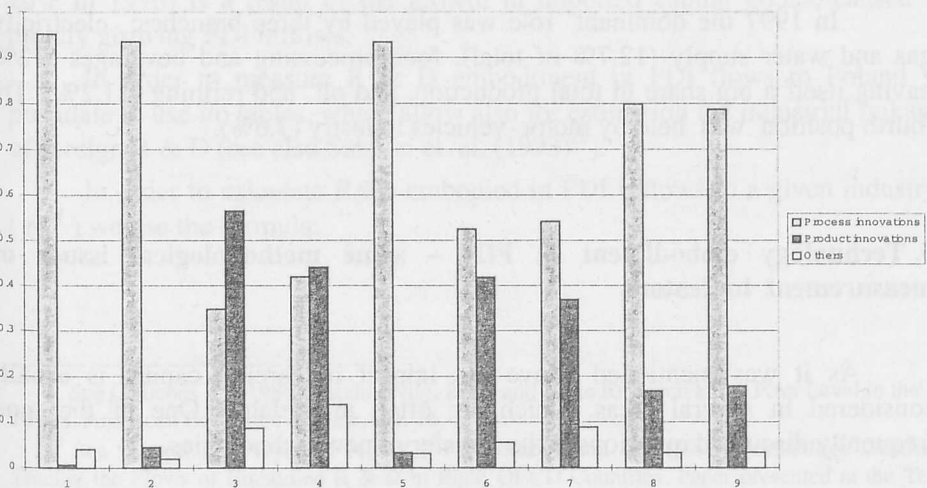


Fig. 2. Innovation outlays by kinds in 1995



In Fig. 1 and Fig. 2 we present the components of innovation outlays for 1991 and 1995 respectively. Generally, process innovations were more differentiated in 1995 than in 1991.

The evident changes concern mineral industry (mostly including building materials) where the proportion between process and product innovations was changed towards the increase of process innovations (new building materials are mostly imported ones). The product innovations also decreased in electro-engineering industry.

According to investigations carried out in 1997 by GUS¹⁸ the innovation activity of enterprises can be characterized as moderately optimistic. In the years 1994-1996 there were 40% of enterprises in the manufacturing sector, in which the innovation activity was observed (for example, its level was only 6% in Russia and 50% on average in Western Europe). Expenditures on innovations in this sector were growing. This growth in current prices was evidently higher than inflation (almost twice more in 1996 compared with 1965 and 37.5% in 1997).

Unfortunately, the innovation activity (and its types) by branches in 1996 and 1997 cannot be directly compared with that presented in figures 1 and 2, because the difference in the methodology of data collecting (in 1996 and 1997 according to Oslo Manual) as well as the classification of branches was changed (NACE in 1999 and 1997).

Generally, however, in 1966 the highest share of expenditures on innovations was recorded in food-processing and beverage industry (14% of total), then in motor vehicles (12%) and metallurgy (8.8%).

In 1997 the dominant role was played by three branches: electricity, gas and water supply (12.7% of total), food-processing and beverages (12%) having itself a big share in total production, and oil and refining (11.2%). The fourth position was held by motor vehicles industry (7.6%).

5. Technology embodiment in FDI – some methodological issues on measurement indicators

As it was mentioned above the impact of foreign capital is usually considered in several areas, which are often interrelated. One of the most frequently discussed questions is the transfer of new technologies.

¹⁸ See GUS op. cit.

In our approach we try to use R&D or similar expenditures as an additional production factor stimulating the efficiency of production process.

For the sake of simplicity it is usually assumed that the technological effects are proportional to R&D expenditures. They are treated as assets and thus, as investments generating "scientific capital" stock. It means that a variable which represents this capital should be included into production function (see e.g. Griliches, 1986)¹⁹. Thus, for example,

$$Y_{it} = Ae^n K_{it}^\alpha L_{it}^{1-\alpha} C_{it}^\beta \quad (1)$$

where K_{it}, L_{it} are two main production factors (capital and labour) in branch i and C_{it} is the non-homogeneous aggregate with a changeable structure representing the stock of "scientific capital". C_{it} can be divided into elements (kinds of R&D expenditures) having different weights and depreciation schemes.

In our case C_{it} will consist, at least, of two elements: domestic outlays on research and development and external ones embodied in FDI.

This is no doubt that the growth of domestic production in Poland has become dependent on foreign technology through FDI inflows being a carrier of R&D flows from abroad.

Two elements of imported R & D inputs can be considered here: intermediate products and capital goods. The latter play the most important role in the transformed economies. The rapid growth of imports to Poland (about 26% in 1996) is a result of the growth in imported capital goods, caused by rapidly growing FDI inflows.

In order to measure R & D embodiment in FDI flows to Poland we postulate to use i/o tables, which allow also for estimation the industrial linkages of foreign R & D (see also Sakurai et. al. (1993)²⁰).

In order to calculate R&D embodied in FDI inflows to a given industry i (R_i^M) we use the formula:

¹⁹ See Griliches Z. (1986), Productivity, R&D and Basic Research at the Firm Level in the 1970's, American Economic Review, vol. 76

²⁰ See Sakurai N., Wychoff A. W., Papaconstantinou G., (1993) Technology Diffusion: Tracing the Flows of Embodied R & D in Eight OECD Countries. Paper presented at the Tenth International Conference on Input-Output Techniques, 29 March - 2 April, Sevilla

$$R_i^M = \sum_k FDI^k \cdot \frac{R_{ik}}{X_{ik}} \quad (2)$$

where FDI^k are FDI flows from country k to branch i . It is assumed that in these flows R&D is embodied proportionally to the share of R&D expenditures in branch k in total output of this branch. These R&D flows are spread over the economy by purchasing the intermediate goods.

For industry j purchasing products from industry i we have:

$$R_{ij}^M = x_{ij}^d \cdot \frac{R_i^M}{X_i} \quad (3)$$

The R&D flows embodied in domestic intermediate products can be calculated similarly to the formula (2):

$$R_{ij}^d = x_{ij}^d \cdot \frac{R_i^d}{X_i} \quad (4)$$

Finally, R&D benefits in branch j can be calculated by summing up direct domestic and foreign expenditures and indirect embodiment:

$$RT_j = R_j^M + R_j^d + \sum_i R_{ij}^M + \sum_i R_{ij}^d \quad (5)$$

These three elements are the components (with different weights and lags) of the above mentioned C_{it} variable.

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