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## **Innovativeness of industry as an aspect of restructuring processes in Poland against the background of the Eastern European Union countries**

### **Introduction**

The restructuring process of the industry of Central and Eastern European countries, connected with the change from the centrally planned to a market economy, should be moving towards the development of intellectually-intensive industries, i.e. those based on knowledge. According to L. C. Thurow (1996) the intensity of transformation into knowledge-consuming sectors of economy influences the economic success of a given state. The skilful usage of both knowledge and information poses the basis for building up innovativeness, which means the ability of subjects and economies to create and introduce innovations, stimulate the activities which trigger off innovativeness, as well as engage indispensable resources (Gierańczyk 2009a). The best evidence of the transformation of knowledge into the direct production power are high tech sectors (Wieloński 2003), which operate at the crossroads of science and industry and are based on processing the results of scientific research. As M. Fic (2004) indicates, the influence of high tech sectors over economy is caused by an exceptionally positive relation between the input and the output. Due to this, high tech sectors belong to the ones which bring the largest profits and which are known as high added sectors. At the same time, high tech sectors stimulate technological advance which in 80%, according to Solow, is responsible for the rate of economic growth (after: Kelly 2001). Besides being highly knowledge-consuming, high tech sectors are characterized by the short life cycle of their goods and processes, fast diffusion of technological innovations, increasing demand for highly qualified labour force, large capital input, high investment risk as well as rapid 'ageing' of these investments (Nauka... 2007).

The development of high tech sectors is tightly interwoven with the introduction of the results of the latest scientific studies as part of work on new technologies and innovative products. Science and technology, on the other hand, pose a key element to the socio-economic development in terms of both national and regional spatial systems (Chojnicki, Czyż 2006; Kobyłko, Morawski 2006; Przybyszewski 2007; Welfe 2007). The processes aiming at restructuring industry, connected with the upgrading the level of its innovativeness, significantly influence the states' international competitiveness (Porter 1990, Ziolo 2008, Wieloński 2007, Gierańczyk 2009b).

This paper's aim is to present the level of innovativeness of the Poland's industry as a sign of restructuring the entire economy against other EU states of Central and Eastern Europe. The analysis will attempt to indicate to what extent the structural changes in Poland's industry, connected with the growing share of high tech sector in terms of employment,

production value, gross added value and profits, indicate positive effects of economic transformation. Modernity of industry is reviewed against the general economic changes in Poland and other states of Central and Eastern Europe at the time of systemic transformation connected with a change of the role industry plays in the economy, and on the basis of its share in the labour force structure and gross added value, structural changes in the industrial sectors and the changes in the structure of export. Special attention was paid to the influence of the level of investments into the R&D sectors, which condition innovativeness of industry, as well as the role of foreign capital in those terms (see: Domański 2001).

The analysis includes those states of Central and Eastern Europe which belong to the European Union. The sources of statistical data were the yearbooks of the Polish Central Statistical Office – CSO (*Główny Urząd Statystyczny – GUS*) and the Eurostat database. It must be stressed, however, that in the case of a few states there were difficulties in obtaining comparable data. Thus, various time spans were selected for the analysis. The issue of significant difficulties in obtaining the detailed statistical data for given time spans and in relation to the development of industry has been already discussed in numerous publications (incl. Rachwał 2008).

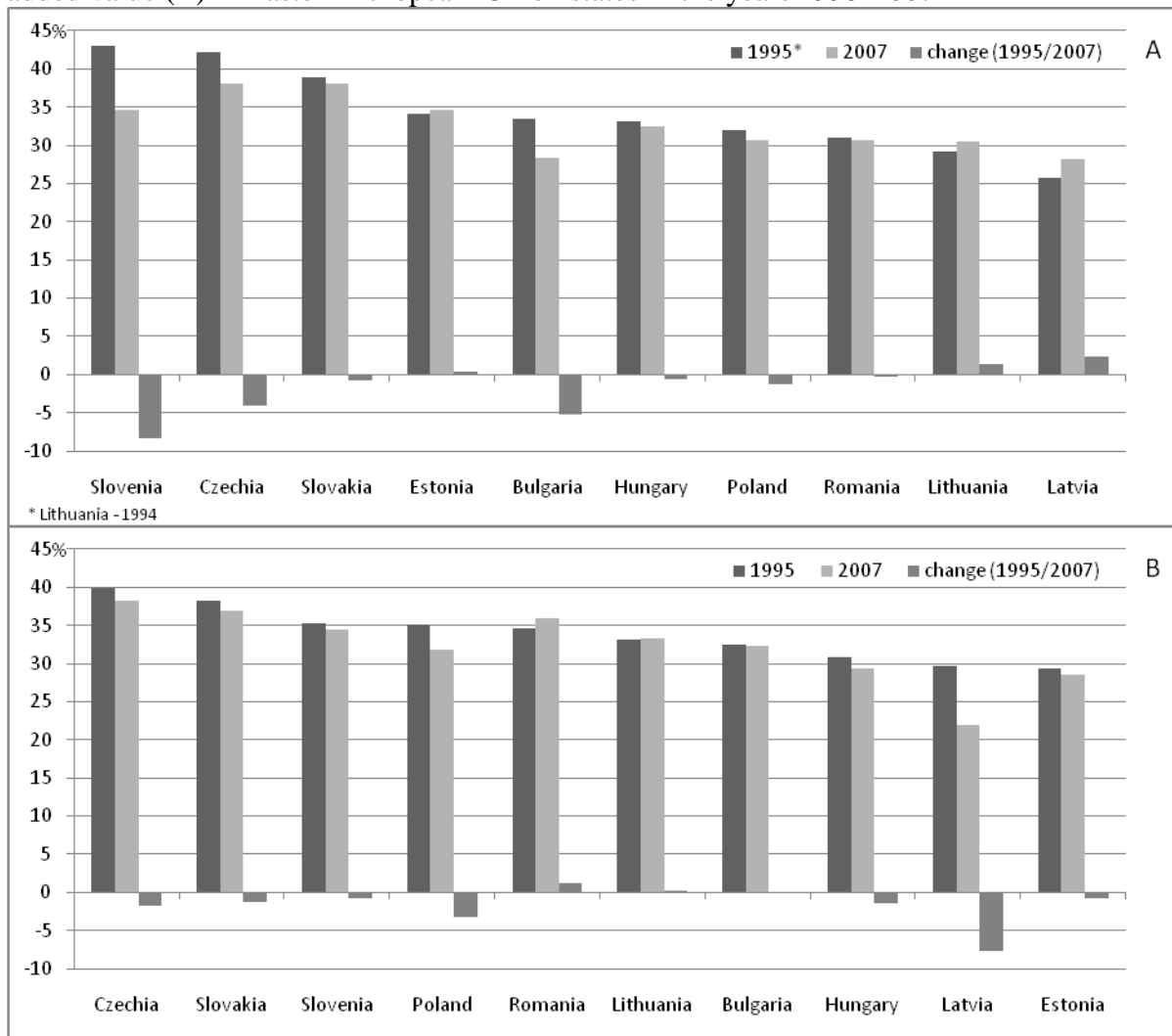
The analysis also includes the results of the earlier studies on innovativeness and competitiveness of the industry of Poland and of other European states (Gierańczyk 2003, 2008, 2009a, 2009b; Stańczyk 2003), the branch structure of Poland's industry (Rachwał 2010), the spatial diversity of industry in accordance with the EU's regional systems (Rachwał, Wiedermann, Kilar 2008a, 2008b, 2009) as well as the changes in the Poland's industry against Central and Eastern Europe (incl. Domański 2003, 2006; Rachwał 2009). The paper, however, uses only the results of the most important researches on the above issues.

### **The changing role of industry in the national economy**

Contemporary changes in the world economy, connected with the transformation from industrial to post-industrial to information-based phase of the civilization development resulting from globalization processes, trigger the changes in the sector structure of the economy. The place of the industrial activity, which used to be the economic basis of the industrial stage of development, is taken by services, especially those which are connected with science and education and become the basic element of the knowledge-based economy. Consequently, the role of industry in the economic development of various spatial systems changes.

The fact that the importance of industry in the economies of the analyzed states is changing finds its support in the data, which indicate that the share of industry in the labour structure and gross added value do change (Fig. 1). Although not in all the states, this share is generally diminishing. In terms of the labour force indicators it is mainly due to mechanization, automatization and computerization of the production processes and, as a result, the elimination of human force in industry. Moreover, this process is also under the influence of systematic increase in the labour effectiveness, which is not only connected with the investments into new production technologies but also with the implementation of new rules of labour organization and management. The latter fact is mainly visible in those firms which have been included into the structures of international corporations, which finds its support in numerous researches on the restructuring processes of production plants in Poland (incl. Domański 2001; Rachwał 2006a, 2006b; Tobolska 2006).

Fig. 1. Share of industry and construction sector in the labour force structure (A) and the gross added value (B) in Eastern European Union states in the years 1995-2007



Source: compiled by the authors on the basis of the CSO data

The differences between the shares of industry in the labour structure and gross added values during the analysed time spans indicate that although this share decreases (by a few percent), which is concordant with the trends all over Europe, in many of the analyzed states it decreases insignificantly or even increases. In consequence, if compared to the Western European states the share of this sector is relatively high, especially in the Czech Republic and in Slovakia where it reaches almost 40%.

On the one hand the above fact shows high durability of the industrial structures which had been shaped earlier under the central planning system. On the other hand, however, at the turn of the centuries the transformation processes brought numerous new investments into the industry of the states of Central and Eastern Europe. This process created new workplaces and increased gross added value produced by industry. Good examples here are investments into the car industry in many regions of Central and Eastern European states, including Poland's Silesian *Voivodeship*, which was analysed in detail by K. Wiedermann (Wiedermann 2007; see: Rachwał, Wiedermann 2008). Other statistical data which prove the above are those which show annual change in the share of industry and construction sector in the labour force structure and in the gross added value in Poland, where their significant decrease was recorded in the years 1995-2001, followed by a period of increase in the years 2002-2007. This increase also resulted from the dynamic development of export production, which was

triggered off by good economic situation in those years as well as membership of the analysed states in the European Union.

Dynamic development of export of industries of Central and Eastern European states was possible thanks to the changes introduced into the technological process which enabled production of more modern goods. At the end of the central planning period, the industrial entrepreneurs in the states of Central and Eastern Europe owned highly outdated machines which did not enable them to produce effectively in the new conditions of market economy. The introduction of deep technological changes was only possible in those companies which had sources of finances for the modernizing process. As the earlier researches indicated (incl. Domański 2001, 2003, 2006; Rachwał 2006a, 2006b; Zalesko 2008; Eaton, Kortum 1999) a leading role was taken by the foreign capital. Poland is this state which during the economic transformation era pulled the largest foreign capital if compared to the other states of Central and Eastern Europe. However, if given per capita, larger investments were located in the Czech Republic, Hungary, Slovenia and Estonia (Domański 2006). In the years 2001-2003 a decrease in the inflow of foreign investment to Poland was recorded, as the state began to lose its competitive position in relation to other states of the region, especially to the Czech Republic and Slovakia. Since Poland joined the European Union a dynamic increase in foreign investment has been observed. Although in the times of the economic crisis a decrease in the foreign investment in Central and Eastern Europe is expected, as the whole region is viewed by investors as less economically and politically stable, Poland's situation is not bad in relation to the other states of the region. This is caused by a relatively good condition of Poland's economy in comparison to the other states of Central and Eastern Europe in the times of the world crisis, the first signs of which were observed as early as 2008.

While analyzing the role of foreign capital in the changes in industry, one must agree with the conclusions drawn by B. Domański (2001). In accordance to him, in general terms the balance of the effects of the foreign capital inflow into Poland and other Central and Eastern European states remains positive. Foreign investments increase competitiveness of both firms and the entire economies of the states of Central and Eastern Europe achieved by the introduction of modern technologies and organization of production which, in turn, raises their effectiveness and triggers off positive structural changes. Higher quality of industrial products means that their export goes up, especially to the so called 'old' European Union (EU-15). Another interesting issue is modernization of technological lines of production which not only enables the companies to modernize and upgrade the products but also decreases the negative influence over the natural environment. Moreover, investors increase competitiveness of local companies and qualifications of cadre. Generating additional profits by cooperation with the local deliverers of goods and services, known as 'multiplier effects', is also of great importance, as it increases employment in the cooperating companies. As a result, foreign investments can be seen as a significant factor influencing modernity of industry.

### **Sector structure of industry**

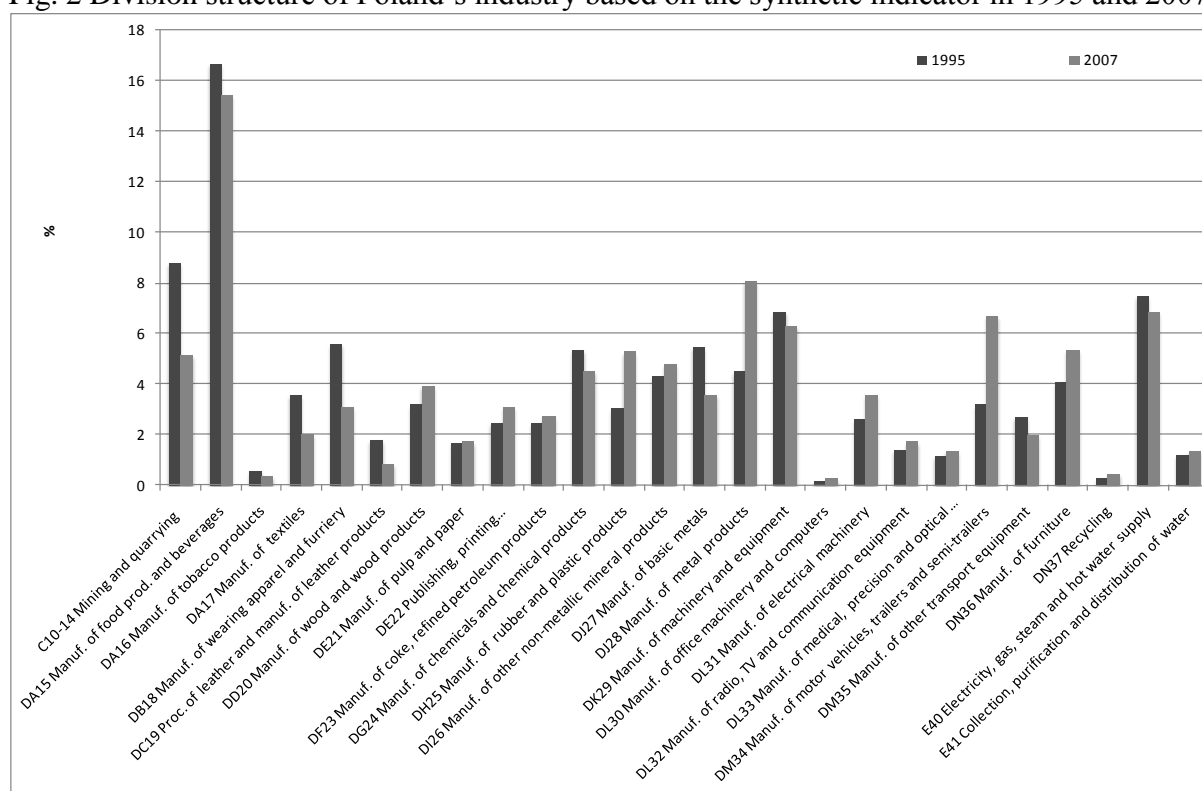
An additional indicator of transformation processes are also the changes in the sector structure. The analysis of this structure for Poland was based on the PKD 2004 (NACE 1.1) sections and divisions, which was in force until the end of 2007. In particular the employment and sold production of industry were considered, as well as a calculated synthetic indicator (Ziolo 1972, 1973) which enabled the authors to synthesize the above two empirical indicators. The advantage of using a synthetic indicator is that its value is influenced by both the number of workforce, which is more important for the labour-intensive sectors, and the value of the sold production, which is crucial for more technologically advanced sectors of

high R&D expenditures. As presently the industry is no longer the factor which activates labour force it would seem inappropriate to use only one commonly used indicator of employment. In such a situation only the labour-intensive sectors of economy would stand out while the modern sectors of economy of highly mechanized and automated production process and high gross added value would be undervalued.

While analyzing the data referring to structural changes in employment in industry in accordance to the sections and branches it becomes clear that the size of employment in Poland's industry during the studied time span decreased by about 13%, while the value of the sold production (in current prices) grew almost fourfold. However, the analysis of the differentiation in employment structure and the value of the sold production in industry by sections, where almost 90% of the share is taken by the section C (Manufacturing), does not allow to draw conclusion on the changes in the branch structure of the Polish industry. Thus, in order to see these structural changes in industry it is necessary to conduct the analysis of the divisions of industry. The largest employment and the highest value of the sold production are recorded by the following divisions: 'manufacture of food products and beverages', 'manufacture of machinery and equipment' and, especially recently, 'manufacture of metal products'. Relatively important role is played by mining (in the analysis mining includes all the 4 divisions of the sector C Mining, as over 90% of the workforce potential is recorded by coal mining).

Modern divisions of production (DL30 to DL33) show relatively low employment potential and small gross added value. Changes in the size of workforce and the value of sold production in the individual divisions are reflected in the changes in the branch structure. There one can observe that the branches of manufacturing food and machinery and equipment show relatively high share although a significant decrease in the importance of mining is visible. If compared to the 1995 ranking, mining has lost its second position for other branches (Fig.2).

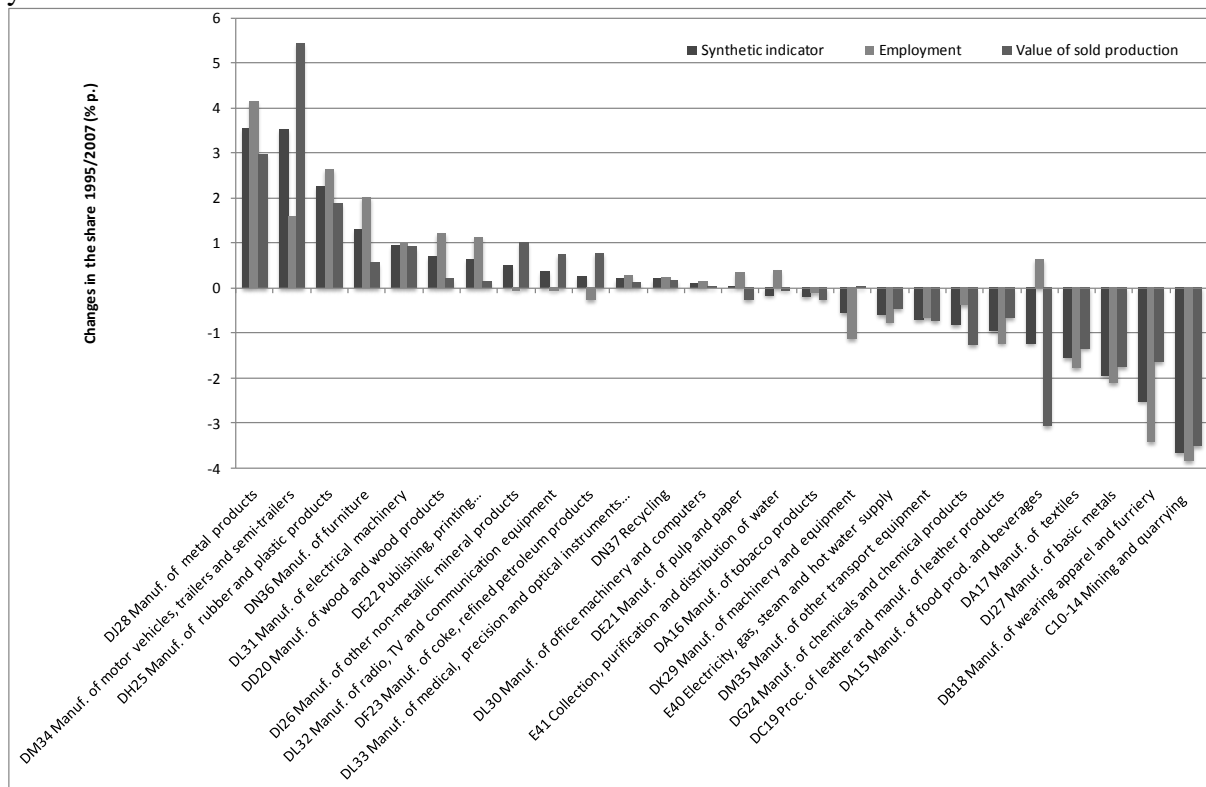
Fig. 2 Division structure of Poland's industry based on the synthetic indicator in 1995 and 2007



Source: compiled by the authors on the basis of the CSO data

As the analysis of the changes in the share of the individual divisions in the structure of both employment and the value of the sold production indicates, more traditional labour-intensive branches, such as mining, manufacturing wearing apparel, textiles, leather products, machinery and equipment, as well as power production and chemical industry are losing their importance (Fig. 3). The divisions which have significantly increased their share in this structure include manufacturing metal, rubber and plastic products, furniture and vehicles. Not all these divisions can be treated as the most technologically advanced. It seems though, that in those specific cases foreign investments are of great importance. Consequently, the share of these very branches increased.

Fig. 3. Changes in the share of individual divisions in the structure of Poland's industry in the years 1995-2007



Source: compiled by the authors on the basis of the CSO data

Nevertheless, stating how the changes in the branch structure of Poland refer to the changes in the other EU states, including those which are transforming their economies, remains an important research issue.

The division structure of industries of individual EU states (for which the data available refers to 1995 and 2007) is diversified. In most states there is a large share of 'manufacture of food products', 'manufacture of machinery and equipment' as well as 'manufacture of metal products'. Although the share of the most technologically advanced branches (DL30-DL33) is relatively low it must be remembered that they are not labour-intensive but show a high level of added value.

The analysis of the similarities of division structures of industries were based on a synthetic indicator which included two empirical indicators from 1995: of the labour force and the size of the gross added value, and on the analysis of clusters (the Ward method). As a result, it is possible to delimit five groups of states of similar division structures (Table 1).

Poland was included into the group four together with other states of Central and Eastern Europe (Bulgaria, Romania, the Czech Republic and Slovakia).

Tab. 1. Similarities of the divisions structures of industries in selected EU states based on the analysis of clusters (by the synthetic indicator) in 1995 and 2007

1995		2007	
Group	Country	Group	Country
1 a b	Belgium, Spain, France, United Kingdom, Denmark, Netherlands	1	Belgium, France, United Kingdom, Netherlands, Spain, <b>Poland</b> , Denmark
2	Portugal, Slovenia, Italy	2	Bulgaria, Romania, Portugal, Estonia, Lithuania, Cyprus
3	Finland, Sweden		
4 a b	Bulgaria, <b>Poland</b> , Romania Czechia, Slovakia	3	Czechia, Slovakia, Germany, Sweden, Hungary, Finland, Slovenia, Italy
5	Cyprus, Lithuania		

Source: compiled by the authors on the basis of the Eurostat data

In 2007 structural changes in Poland's industry, however, resulted in a situation where, out of three delimited groups, Poland fell into the group number one together with Belgium, France, the United Kingdom, the Netherlands, Spain and Denmark, and not, as it might have been expected, into the same category as the other Central and Eastern European states. Thus, structural changes of the branches of industry in Poland lead to the situation in which this structure takes the features of the highly developed EU states which, from the point of view of the goals of economic transformation, is a highly positive phenomenon.

### Development of the high tech sector

Active policy of innovativeness, creativity and development of industrial firms is visible through structural changes of production, which show the increase in the abilities to produce new and modern goods. The branches which might be called 'modern' existed at every stage of the economic development. Modernity stems from using the technological processes and technical solutions by a given branch which are later ingrained into the products of this branch of industry.

In the times of the knowledge-based economy the ability to produce technologically advanced products, the demand for which is growing faster than for traditional goods, proves the industry in modern. Dynamic increase in the demand for the goods filled with knowledge is the consequence of the evolution of consumption habits, which are predominantly created by the educated and rich societies desiring to meet their more and more sophisticated needs. Contemporarily, an important role in stimulating this demand is played by the media which instantly deliver the news on the latest technological advancements and thus effectively transfer consumption trends. The ability to adjust the production structure to the market needs decides about the conditions of international trade. This is because the state's technological abilities and the abilities to export are interwoven.

The idea of high technology industries, also called high tech or simply HT, appeared first time in the specialist literature in the mid-1960s, with the sudden development of modern – by the then standards – branches of economy (Wiśniewska, 2002). Generally, this category includes the branches which operate at the crossroads of science and industry, and the basis of which pose the results of scientific researches. Presently, the EU nomenclature delimits high tech sector on the basis of the OECD's methodology which was developed for the years 1980-1995 and uses branches. Table 2 presents these high tech branches in accordance with the above classification.

Tab. 2. High tech industries by NACE Rev 1.1

Codes	Manufacturing industries High-technology
24.4	Manufacture of pharmaceuticals, medicinal chemicals and botanical products
30.	Manufacture of office machinery and computers
32.	Manufacture of radio, television and communication equipment and apparatus
33.	Manufacture of medical, precision and optical instruments, watches and clocks
35.3	Manufacture of aircraft and spacecraft

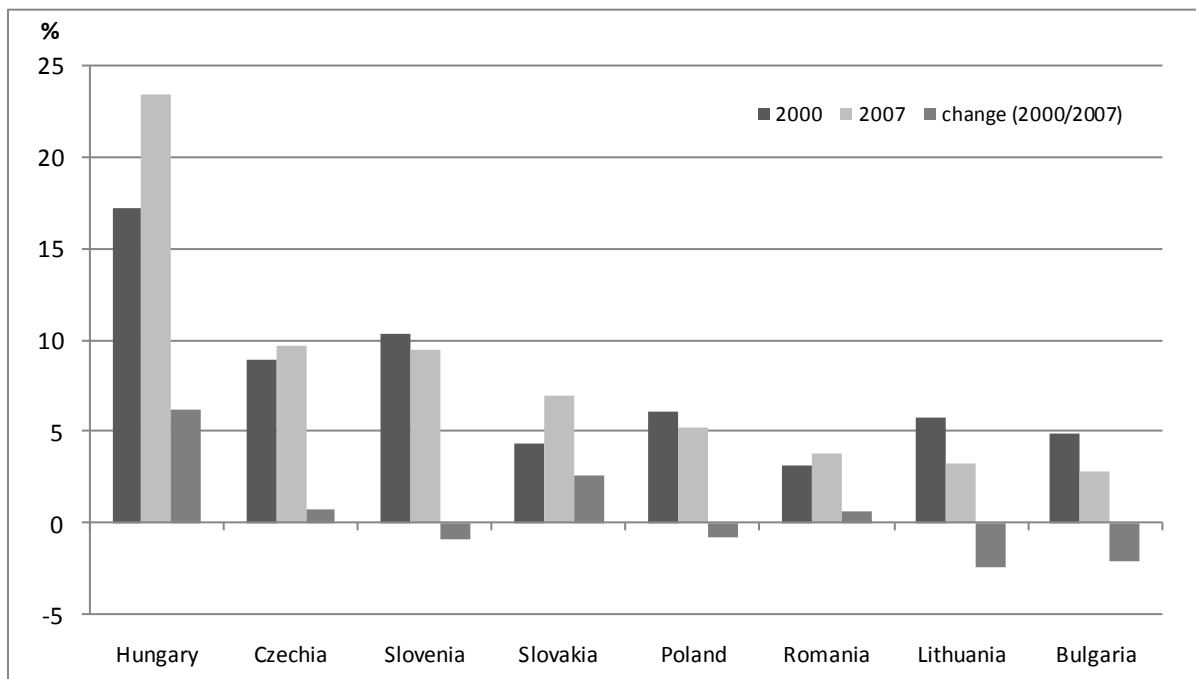
Source: NACE (Nomenclature statistique des Activités économiques dans la Communauté Européenne) Rev 1.1

Irrespectively of the methodology of assessing the value of the R&D sector, the basic indicator of a modern industrial structure of the contemporary knowledge-based economy is the one which shows the share of the high tech goods within the entire production (Karpiński 1994). Production of high tech goods is one of the most dynamic elements of the world economy and economic changes triggered off by the appearance of high tech branches, followed by their spectacular development, are so large-scale that are treated as those which in fact add dynamics to the reality. The role of this factor, treated by the classical economy as the residual value, was described by R. Solow in the 1950s. He proved that technological advancement, which decides about the productivity of the other production factors, is responsible for 80% of the economic growth (after Kelly 2001). Presently, the ability of the economy to move to a higher level of technology and, consequently, better economic, social and ecological effects, remains the key factor which describes ability to achieve the long-term and effective economic growth (Fic 2004). As a result, the state of the development of high tech sector, and especially the share of the high tech goods in export, is treated as one of the basic indicators of modernity and competitiveness of a given economy.

According to the earlier studies (Gierańczyk 2010) the highest and constantly growing share of high tech goods in the industrial production is recorded by the best developed states in the world, such as Japan (about 16%), the USA (about 21%) and South Korea (19%) (Turowski 2005). Although in Poland the number of the HT firms increased from 600-800 in 2000 (Rot, Brodzicki *at all.* 2001) up to over 2000 in 2007 (Świdurska 2009), the value of the HT production within the entire industrial production dropped and was one of the lowest from among the Eastern EU member states (Fig. 4). This means that the technological gap between Poland and the leaders of innovativeness is widening. As Grudzewski and Hejduk (2008) indicate, the so called technological gap of high tech products shows that in most high tech branches Poland remains delayed by over five year in relation to the world leaders of innovativeness. Besides, it also means the following:

- lowered level of competitiveness of numerous Polish products on the world markets,
- a significant advantage of foreign products, which often come from the countries of medium level of development,
- lower productivity of many of the foreign technologies used in Poland's industry,
- overuse of materials, resources and energy,
- too wide range of the products offered by one company which limits specialization and the ability to reduce unit costs.

Fig. 4. Share of the high tech sector in the production structure in Eastern European Union states in the years 2000-2007



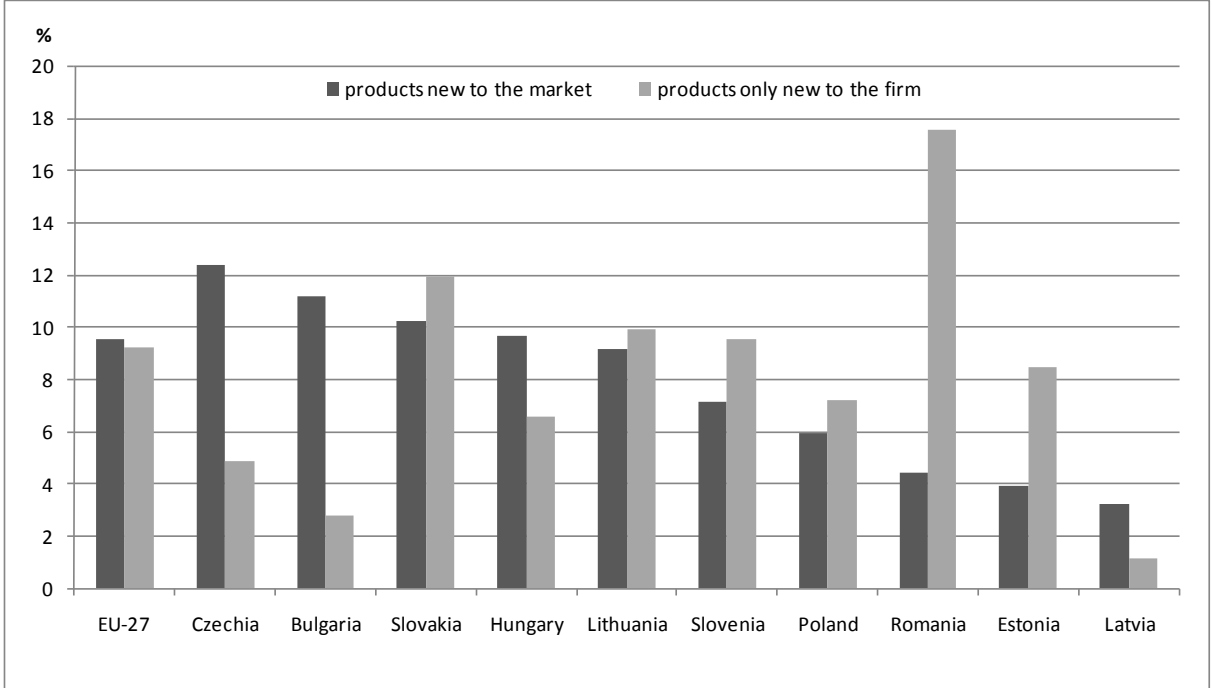
Source: compiled by the authors on the basis of the Eurostat data

In spite of the fact that similar tendencies in the development of the HT sector in Poland in terms of the structure of the added value were observed, there are symptoms which indicate the modernizing process of the industrial structures of the country. It is because from the point of view of the economic growth not only the high tech production is crucial. Other important factors include the level of using modern technologies to produce goods of lower technological advancement. Considering the fact that in the study period Poland recorded a 5% growth in the share of the sector of medium technologies at the expense of low technologies, it seems there is a tendency to increase quality and reliability of products, which indicates a better use of the capital resources.

At the same time it is observed that the dynamics of the increase in the production of HT goods in Poland was lower than in the other sectors of industry. This means that the modernizing process is being achieved by the increase in the production of those goods which showed a larger technological delay than the HT products. This tendency is proved by a higher share of the value of the sold products which are new only for the companies (Fig. 5). New items introduced into the market by the Polish firms for the first time are rather rare and, as the research reveals, this is mainly done by the companies with the foreign investments. Good examples of such practices are the factories Isuzu in Tychy and Volkswagen in Polkowice Dolne which produce the latest models of Diesel engines. The company Alstom Power Generators (previously ABB Domel) in Wrocław specialises in creating unique prototypical generators. In Piła Philips introduced mass production of the most modern sources of light. Other most modern companies include pharmaceutical firms with foreign investors, which in terms of technology and culture of production are no worse than the West European firms. A good example here is Pliva Kraków, which together with Pfizer patented a modern antibiotic. In 2008 the share of new products on the export markets was insignificant, and amounted to less than 2%. The examples of companies producing for the European or global markets include ABB Elta from Łódź, which has the status of a European concern producing distribution transformers, ABB Zwar from Warsaw which produces capacitor

voltage transformers, SKF from Poznań which is the producer of some assortment of cylindrical and conical bearings, and Philips in Kwidzyń which produces television heads (Zalesko 2008).

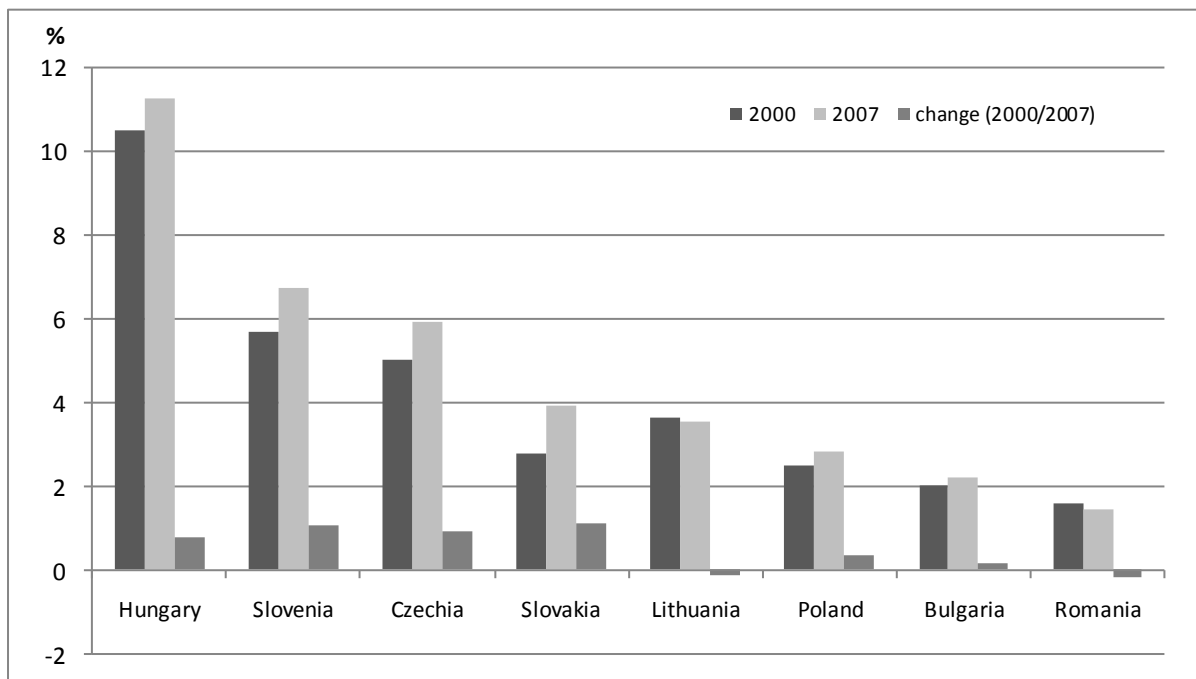
Fig. 5. Share of new products for the market and for the company in the value of industrial production in Eastern European Union states in the years 2000-2007



Source: compiled by the authors on the basis of the Eurostat data

In the study period the changes in the share of the HT in the structure of the value of production and the added value differed from the structure of labour force. Although in Poland there appeared a general tendency to decrease the number of those employed in industry, the amount of those working in the HT sector actually increased, while the tendency to decrease the number of those employed in the low tech sector was significant. This means that the sectors of lower technological advancement recorded the decrease in the size of labour force due to the increased labour efficiency as well as mechanization, automatization and computerization. In the HT sector, however, the growing need for workforce, mostly highly qualified, was generated by the research and development departments, especially in the companies with foreign investment. The supply of well educated graduates of technical institutes of higher education is an advantage of Poland. This means the perspectives of the development of innovative thought is large. However, there is an obstacle to this perspective, which is an awareness of the need to develop cooperation between science and business. In 2008 there were only 1.6 paper per 1 million inhabitants published as a result of such cooperation, which is over 20 times lower than the average of the EU-27.

Fig. 6. Share of high tech sector in the structure of workforce in Eastern European Union states in the years 2000-2007



Source: compiled by the authors on the basis of the Eurostat data

In Poland, According to the results of the research conducted by the Ministry of Science and Higher Education (Bariery... 2006), the main barrier for both science and business for cooperation is the barrier of awareness. As much as 20% of Polish entrepreneurs do not know that the cooperation with scientific environment is possible, almost 40% of firms do not know how to get in touch with the scientific centres interested in commercialization of their research results, only 10% of the companies view the cooperation with the scientists as a chance to increase their export potential, and entrepreneurs complain there are no legal incentives and concrete offers from the scientific centres. On the other hand, scientific environment does not open itself for cooperation with companies due to numerous limitations, including the following:

- motivational (the benefits are much smaller than the input),
- institutional (reluctance of the heads of institutions of higher education to commercialize the results of the scientific research of their workers),
- informational (communication barriers between these two environments),
- administrative (bureaucratic limitations to the process of transfer of technologies),
- organizational and financial (diverse style of work of scientific workers and entrepreneurs; relatively limited financial resources of companies and, as a result, weak incentives for scientists to cooperate with businesses – Raports of MNiSW [2006], PARP [2009, 2008, 2007, 2006], IBnGR [2008]).

In accordance with the analysis of the results, the structural changes observed in the years 2000-2007 in Poland's industry are very slow and predominantly take place in the sectors of low technological advancement. It remains an important research issue to answer the question to what extent the modernizing processes in Poland's industry refer to the changes in the other EU states, especially those at the process of the economic transformation.

The attempt to analyze similarities in modernity of industry's structures (based on a synthetic indicator which includes four empirical indicators, i.e. the value of production, gross added value, profits and workforce) was conducted on the basis of the analysis of clusters

(Ward's method). Both in 2000 and in 2007 the territory of the EU was divided into four groups of states (Table 3). Poland fell into the group four, which has the lowest level of modernity within the entire study area. This group also includes other Central and Eastern European countries, such as Bulgaria, Romania and Lithuania, but also Greece and Spain.

It has been noted that during the study period of time the distance between groups of states of the lowest and the highest level of modernity increased. In terms of the states the largest distance growth was recorded between Romania and Hungary, as well as between Poland and Hungary. In the last decade the HT sector in Hungary stood out from among the other countries as this sector had a much larger dynamics of development than the industry in general, while in Poland the HT branches were developing at the same rate as the industry in total.

Tab. 3. Similarities of modernity of branch structure of industries of selected EU states based on the analysis of clusters (by synthetic indicator) in 2000 and 2007

2000		2007	
Grupa	Państwa	Grupa	Państwa
a	Finland, Ireland,	a	Finland, Ireland, Sweden, Hungary
b	Belgium, Denmark, France, Sweden, United Kingdom, Hungary, Slovenia	b	Belgium, Denmark, France, Netherlands, United Kingdom, Slovenia
c	Austria, Germany, Italy, Netherlands, Czechia, Lithuania, Bulgaria, Norway	c	Austria, Germany, Italy, Czechia, Slovakia, Norway
d	Greece, Spain, Portugal, Cyprus, Poland, Slovakia, Romania	d	Greece, Spain, Portugal, Cyprus, Lithuania, Poland, Bulgaria, Romania

Source: compiled by the authors on the basis of the Eurostat data

The development of the HT sector, the products of which made over 30.3% of the export value in 2007 (in Poland 3.1%), was significantly supported by foreign investments into this very sector. To ease this process, a number of legal, administrative and financial instruments were created. Paradoxically, besides its developed infrastructure the attractiveness of Hungary was increased by the relatively restrictive law regulations on the protection of intellectual property. However, at the beginning the investments Hungary followed the same path as the other states under transformation. International companies invested in Hungary mainly due to low labour costs and the accessibility of the home market. With time, however, the possibility to use the country's technological potential was becoming more and more crucial. As a result, the local system of research and development had to take the challenge of supporting research of large international corporations as well as increasing the existing subvention systems. Last but not least, it was important to strengthen the interrelations between science and firms which would foster the development of their own high technologies. The key element of attracting foreign investments into Hungary was the development of the national system of innovative institutions which cooperated with large international corporations. As a result, at the end of the 1990s the research and development undertakings and other pro-innovation processes were intensely stimulated by foreign investment. Today, thanks to the fact that more and more international companies locate their research and development activities in Hungary this state has become the headquarter of numerous research and development centres which stimulate the engagement of firms into innovative activities of R&D (Woodward 2003).

The position of Poland in the group of the lowest in the EU level of modernity of structures indicates there are limitations to the modernizing process of industrial structures in Poland. Numerous researches, e.g. by Stawasz, Głodek, Mizgajska, Wiszniewski, Platonoff, Miłaszewicz, Sysko-Romańczuk (after: Bieñkowska *et al.* 2007) indicate that these are predominantly financial obstacles. Limited possibilities of financing innovative activities from inner sources and the barriers to acquiring capital from the outside sources mainly

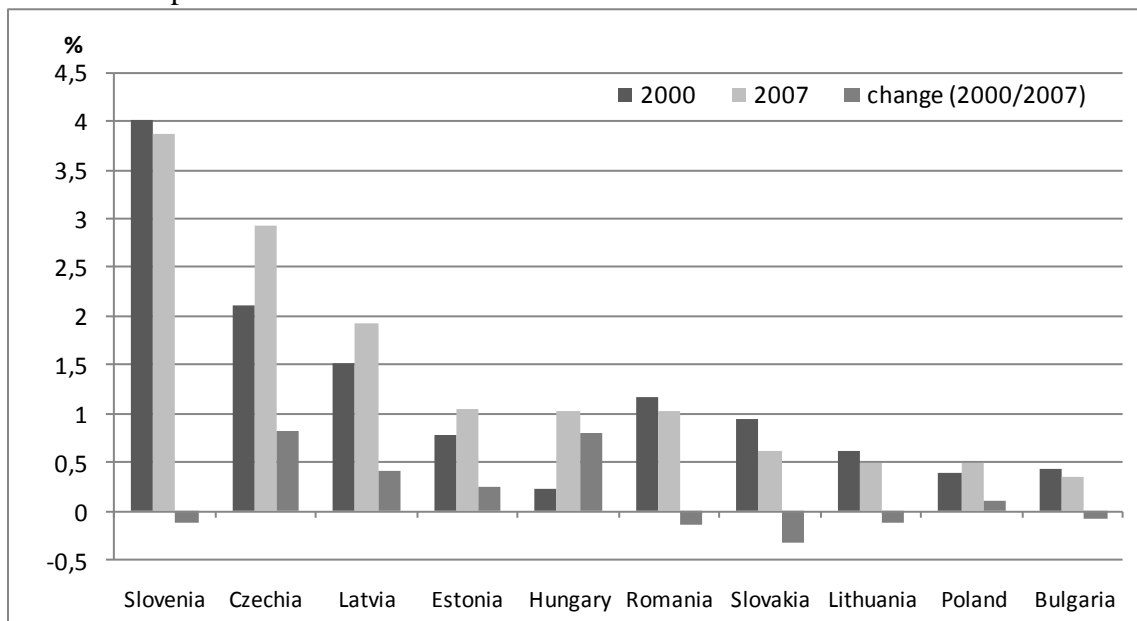
determine the decision of upgrading the machinery. In 2008 in Poland almost 90% of the capital spent on innovations was spent on investment into durable resources (91.5% – Fig. 9), including mainly machines and equipment. Such a structure of using the capital devoted to innovativeness implies that companies are trying to narrow the technological gap as soon as possible and with the use of outside material technology (Gaczek, Strykiewicz 2008).

### Research and development

In the era of globalization it is widely accepted that the most effective way of economic advancement is properly directed scientific research, which is later used in practice to develop technologies. Stimulation of scientific research is the element of innovation policy of every modern state. On the one hand, scientific and technical achievements pose a valuable and searched good, which itself might be a source of significant financial profits, i.e. in the form of sold licenses, know-how and technologies. On the other hand, the material goods produced by industry which include modern technological thought belong to the most attractive products on the market, especially in international trade. The abilities of companies to use the results of research and development works in the form of both new and modern goods and upgraded old products introduced onto the market decides whether an economy is competitive internationally (Gierańczyk 2010).

In order to assess industry's potential for innovativeness, a relation between the value of expenditures on the B&R in industry and the gross added value was used (Fig. 7). This indicator shows a weak position of Poland. The country, despite introducing the rules of Lisbon Strategy, together with Bulgaria and Slovakia belongs to the states in which the expenditures on the R&D decreased in the years 2000-2007. From the point of view of the development of the knowledge-based economy the decreasing R&D activity of the Polish companies is disadvantageous. This is so because scientific researches, if well directed and practically used for the technical development, are presently the most effective way to build competitiveness of industrial firms, as well as of the regions and states connected with them, on the international scene.

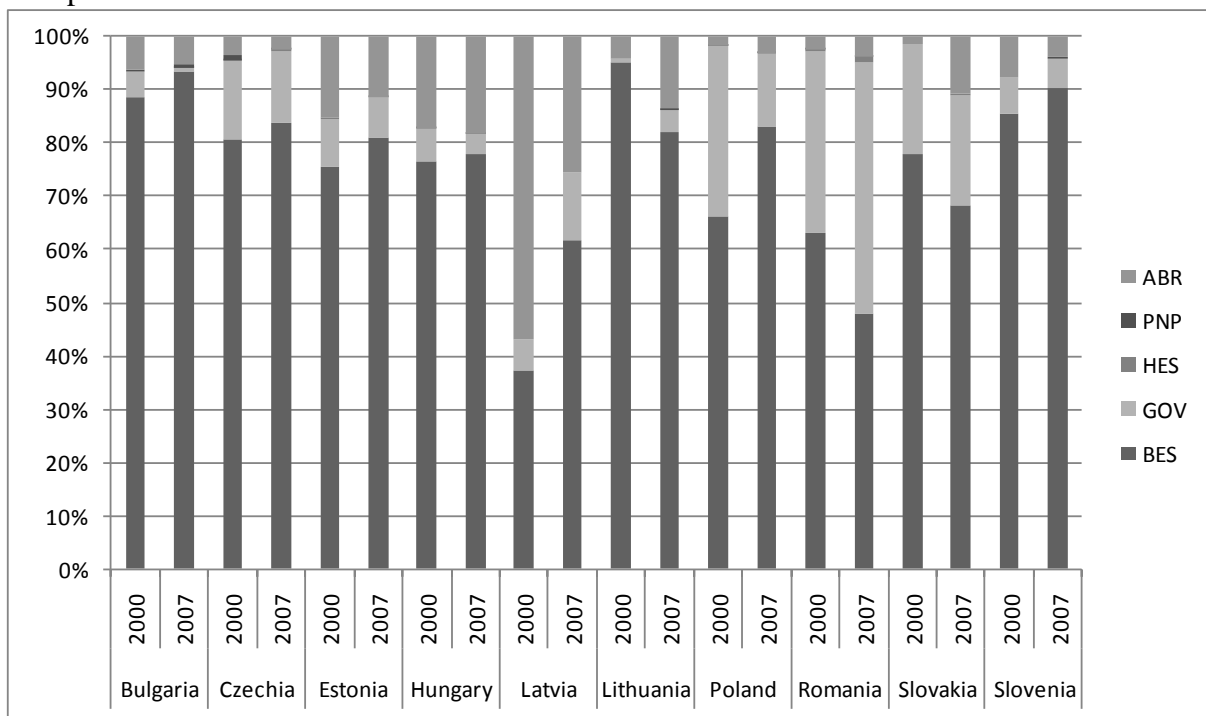
Fig. 7. Input into research and development as part of the added value in the industry of Eastern European Union states in 2002 and 2007



Source: compiled by the authors on the basis of the Eurostat data

A key reason for the decrease in the share of the R&D expenditures in the total investment into innovation in Polish industrial firms is the fact that there were limited state subventions while the level of spending from the own firm sources stayed unchanged. As a consequence, a relative change in the structure of the R&D expenditures in industrial firms was recorded. At the same time, the share of the expenses from the own companies' resources increased from 66% in 2002 to 83% in 2007 (Fig. 8).

Fig. 8. Structure of sources of capital for the R&D activity in the industry of Eastern European Union states in 2000 and 2007

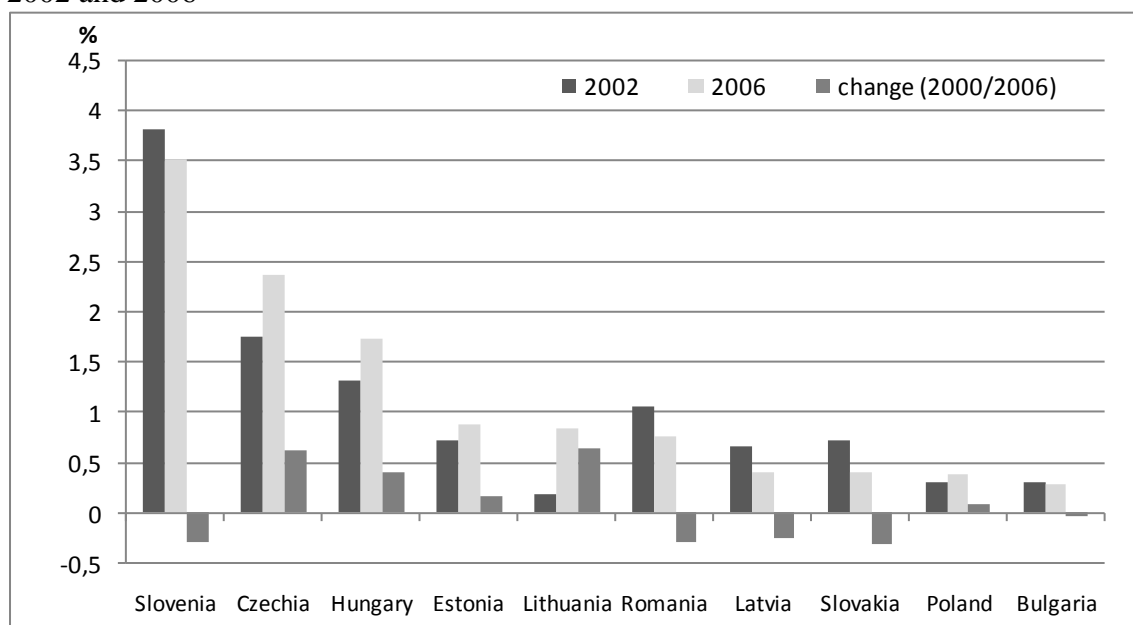


ABR - Abroad, PNP - Private non Profit, HES - High Education Sector, GOV - Government, BES - Business Enterprise Sector.

Source: compiled by the authors on the basis of the Eurostat data

Due to this process, the structure of sources of the R&D capital in industrial companies in Poland became similar to this of highly developed countries. Such a situation cannot be treated as a positive one as industrial companies have little abilities to create innovative activities. In 2007 an indicator of intensity of innovation in Poland's industry, which shows the relation between the expenditure on innovative undertakings and the value of sales, belonged to the lowest among the EU states and was much lower than in Slovenia, the Czech Republic and Hungary (Fig. 9).

Fig. 9. Indicator of intensity of innovation in industry of Eastern European Union states in 2002 and 2006



Source: compiled by the authors on the basis of the Eurostat data

The reasons for the inadequate engagement of Polish industrial companies in the activity and financing of the R&D sphere include, for instance, high costs and large risks if such activity is undertaken. Small and medium firms, which predominate in the Poland's economy, lack their own capital to undertake R&D activities. At the same time, banks are reluctant to give loans for such projects, as they treat creating the R&D sector as highly risky and expensive. There is also no high-risk capital, which in many states makes an important instrument for introducing scientific research and development and innovative activities into the economic practice (Grodzka, Zygierewicz 2008). In this situation the growing share of companies in financing research and development activity causes apprehensions. This is because in highly developed states the growing engagement of industrial companies into creating innovations results from a long-term development policy, while in Poland starting these mechanisms necessitates reorganization of the innovative system.

At the time of socialist economy Poland, similarly to the states of Central and Eastern Europe, accepted the innovation model based on the cycle of science-technology-production, where the main responsibility was on the inventors and not on the entrepreneur (Kwiatkowski 1990a). In this model the forces igniting innovations were the central institutions of political power (Gomułka 1998). S. Kwiatkowski described these tendencies in the scientific and technical policy as the 'diverted development', which meant that well educated research cadre worked intensively but without proper direction and thus bringing no expected results. Overdeveloped state research centres generally did not take part in the innovation market and thus were reluctant to find answers to the key questions from the players on this market (Wasilewski, Kwiatkowski, Kozłowski 1997). It was generally believed that the most important element in the innovation processes are investments into researchers and their development (Kwiatkowski 1990b), while there were no institutional conditions for creating and diffusing innovations.

The attempts to adjust the R&D sector to the market economy rules during transformation in Poland did not bring reasonable effects. There are no clear institutional frames which would enable the companies to benefit from scientific research, no encouragement to actively create knowledge and using it for the development of the firm's

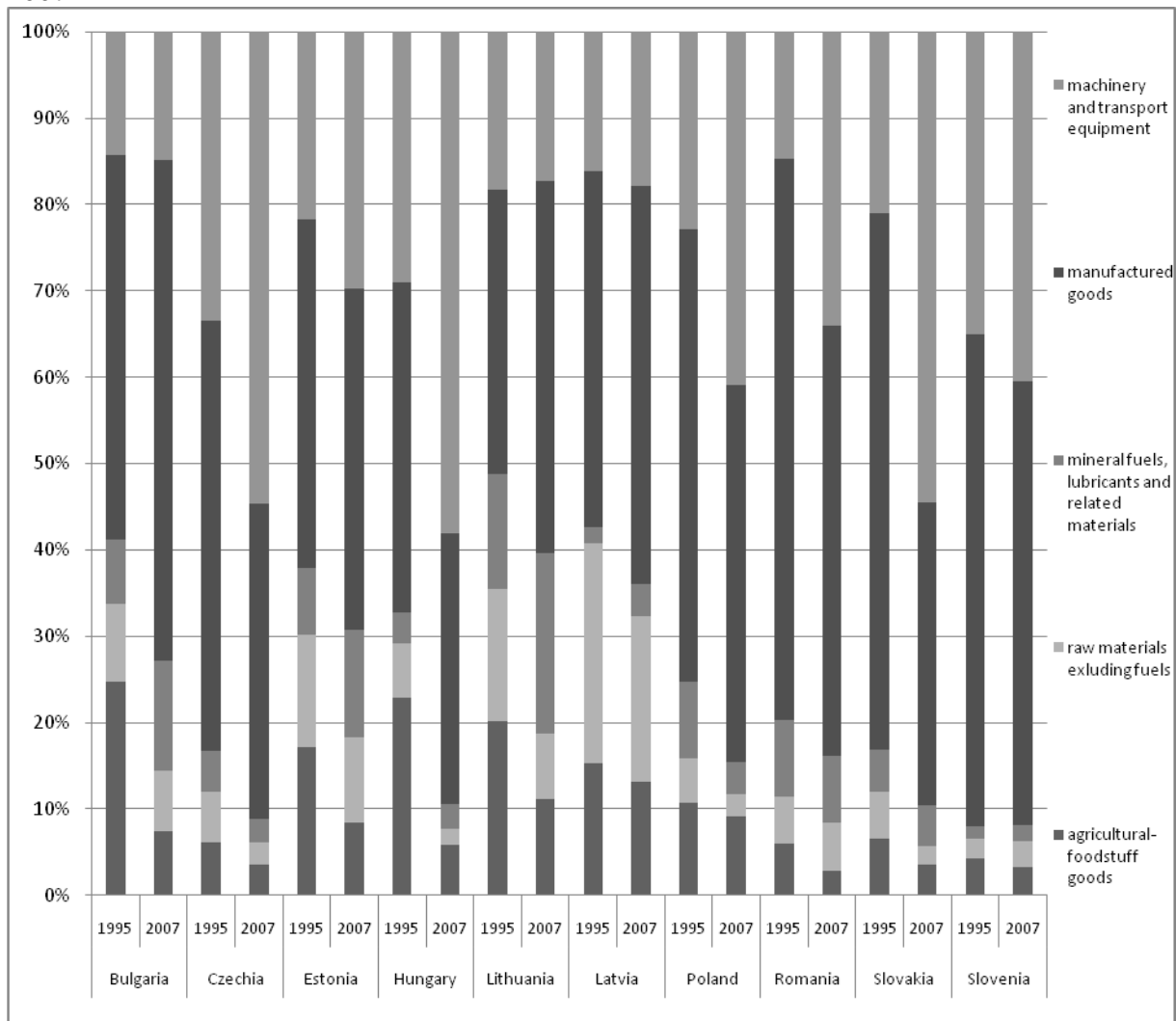
own products. Moreover, there are no institutions to intensify transfer of technologies between state research centres and firms. One of the important issues is that of the scale and effectiveness of public subventions into research and development projects in companies. In this situation state interventionism may be viewed as an instrument to fight imperfections of the capital market, which discourages companies from long-term investments into the R&D (Lach 2002). This is because the inflow of the state money may increase the profitability of the projects which in other circumstances would not be undertaken or continued (Wallsten 2000). Moreover, from the theoretical point of view, the governmental subsidies into the R&D sector trigger off the following: a) increase of the total expenditures of the national economy on research and development by increased public input without a change to the level of the expenditure of the private sector (direct effect), b) a positive reaction of companies on state subsidies and thus increasing own expenditures in the same field (indirect effect). However, this interdependency is not fully supported by the empirical research (Klincewicz 2008). On the contrary, the results of the research undertaken in the 17 OECD states indicate that the positive impulse coming from governmental subsidies is short-lived. This is because in a longer perspective there is a strong effect of displacement by artificially increased demand for the research services and, as a result, the growth in their prices, which finally distort the balance on the specialists' market. It must be remembered, however, that the development of technologies is a long-term process, which needs a constant inflow of capital and thus limits the benefits from a short-run stimulation. Effectiveness of subsidies depends on, thus, on the institutional aspects of the subvention program, which includes a definition of beneficiaries (small or large companies), the level of necessary investment of the own firm's money (as the specialist literature suggests, at the beginning the effectiveness of subsidies increases with the growing percentage of governmental support but then rapidly decreases (Guellec, van Pottelsberghe 2003), or the specificity of the projects (the relation between key technologies and export).

Other serious issues include the inability to assess the effects of programs by public institutions and using the subsidies as an equivalent of prize for the recent achievements of companies and not as the mechanisms reducing the imperfections of the market and stimulating innovativeness (Wallsten 2000). The assessment of the investments into the R&D in the Poland's industry shows, alas, that they are ineffective if compared to both the developed economies of Western Europe and the neighbouring states in the region. Financial subsidies are mainly dedicated to the basic research, the results of which cannot be commercialised. Limiting budget subsidies may thus induce the companies to orientate themselves to practical research which would increase the competitiveness of firms, but in the long run and through starting instruments motivating to increase the expenditures on the R&D. There have been a number of undertakings recently, as part of the development strategy co-financed with the EU funds for the years 2007-2013, which aim at increasing the level of commercialisation of the results of the scientific research and increasing the range of cooperation between science and industry.

### **Export structure**

The transformation tendencies in the industry of Poland and other EU states of Central and Eastern Europe are visible in the export structure of these states (Fig. 10). Dynamic increase in export to highly developed states as well as a visible increase of the share of modern goods, such as machinery, equipment and vehicles as well as other products of manufacturing, should be viewed as highly positive. Such changes are especially visible in Hungary, the Czech Republic and Slovakia. This positive tendency of the changes in the export structure was also recorded in the earlier research by B. Domański (2006).

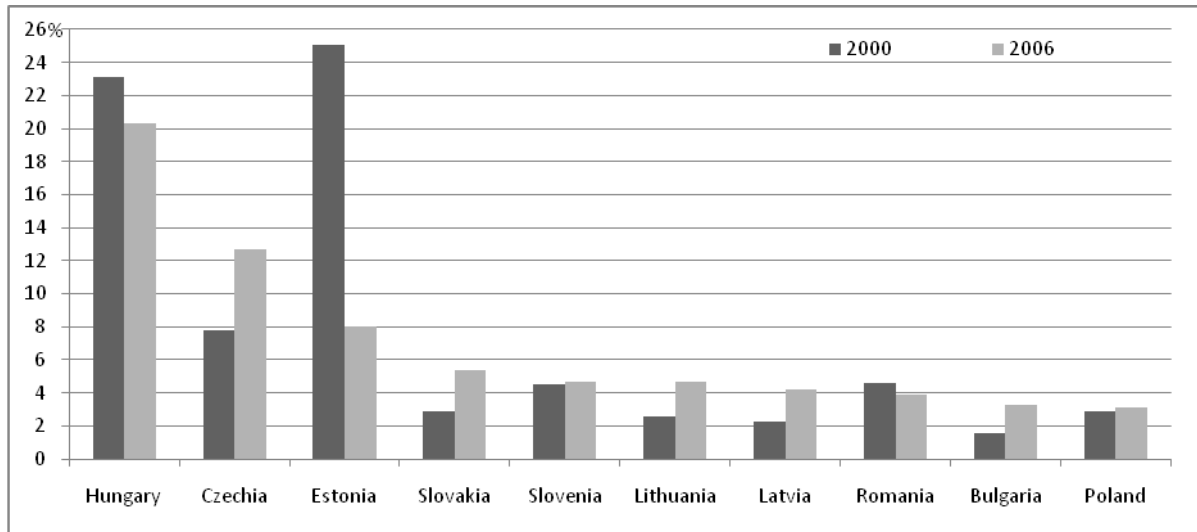
Fig. 10. Changes in the export structures of Eastern European Union states in the years 1995-2007



Source: compiled by the authors on the basis of the CSO data

Unfortunately, most of the products classified as machinery, equipment and vehicles may only be classified as goods of medium level of modernity (the so called ‘medium technology’ according to the OECD classification). This does not mean, thus, an increase in the share in the exported goods of the high tech products (HT). In those terms the states of Central and Eastern Europe record significant diversities. In terms of the share of the HT goods in the total export, Poland takes the last position among the states in its group as this level is much lower than the EU-27 average of 16.7% (Fig. 5). It is interesting to see a high share of the HT in total export in Hungary and a significant increase of this sector in the Czech Republic. These countries intensify foreign trade in HT goods, and benefit from globalization. In order to join this group of producers who are accepted on international markets Poland must intensify the development of technologies and modernizing processes of the industrial structures for high intensity of research and development.

Fig. 11. Share of HT goods in total export of the states of Eastern European Union states in 2000 and 2006



Source: compiled by the authors on the basis of the CSO data

## Conclusions

The presented analysis of the changes in Poland's industry against the other Eastern EU states for its modernity enables the authors to draw the following conclusions.

- In the researched period of time the share of industry in the workforce structure and the gross added value show decreasing tendency both in Poland and in most of the studied states, although in some countries there is a slight positive tendency. Small decreases of the share of industry in the years 1995-2007 influenced the fact that Poland still remains within the EU states of high share of industry in the national economy.
- Structural changes into the branches of industry lead towards the structure of the highly developed states of the EU, such as France or the United Kingdom, which from the point of view of the goals of transformation should be assessed as highly advantageous. They are made, however, on the basis of activating the resources unused until now and not by gaining new competencies, like in Ireland where the basis of the economic growth was a sudden increase in effectiveness and finding the state's own niche in the high tech sector.
- If compared to the other states, Poland shows relatively low share in employment and gross added value of highly advanced sectors of the economy, which can be caused by disadvantageous tendencies in Poland in terms of employment and expenditures on the R&D sector against the other states.
- Positive changes are recorded in the export structure of the states of Central and Eastern Europe, which means the processes of modernizing this sector and increasing the competitiveness of its products (technological and product innovations) is advancing. In Poland, however, the share of the HT goods in export is exceptionally low if compared with the other states of the region and the EU average.
- Central and Eastern Europe remains one of the most attractive regions of the world in terms of foreign investment. Although the inflow of these investments into Poland, if given in absolute numbers, remains the highest in the region, the indicator of foreign investments per capita is relatively low; this means there are still unused possibilities in term of attracting investments and there still exist barriers of administrative, legal and financial character (especially in terms of tax and social insurance laws), which deter investor from Poland.
- In general, the inflow of foreign capital is advantageous for the restructuring industries in those countries, but in the other states of the region this capital is used for increasing

modernity of industry by investing into the research and development sector while in Poland it is not.

- In the years 2000-2006 in Poland, while the general increase in the expenditures on innovative activities in industry was recorded, the main amount of money was directed into the investments in machinery and equipment. In the research period of time the share of the R&D expenditures in the total amount of money on innovations remained low (8-12%) and showed a decreasing tendency, while in 2006 in the Czech Republic and Hungary it remained at the high level of 40%.
- The financial sector, as it seems, is the main barrier to the abilities to increase innovativeness in Poland's industry. It is necessary, though, to undertake activities so as to attract the outside sources to finance the research and development projects. A good example of such activities is Hungary, where employment, expenditures on the R&D sector and the share of the HT sector are very high.
- Tightly interwoven with the international networks, the HT sector in Hungary, the potential of which exceeds the country's demand, is mainly orientated at the export markets, which makes it vulnerable to the world events. In accordance with the research results of Nemethné, Katalin-Pocsarovszky (2009) it may be concluded that the HT sectors were hardest hit by the sudden drop in demand during the world crisis. The HT producers lost their clients all over the world, which resulted in limiting stocks and decreasing of production. This unfavourable trend was halted in spring 2009.

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