

## Sources of Research and Development (R&D) Financing in Poland

*Analysis of trends and structure of expenditures on research and development in Poland during 1994-2001 Poland's patterns are compared with those of the OECD countries*

### SPHERE OF R&D ACTIVITIES

The sphere of the research-and-development activities encompasses, in institutional terms, the totality of units, in which the R&D activities is being conducted. This sphere can be characterised through various measures. If we adopt as the basis of measurement the synthetic yardsticks, applied in the national statistics, which can be used with respect to the entire national economy or its appropriate fragments, then the characteristics considered would be based on such ones as: the number of institutional units, the number of persons employed, the global value and the gross value added.

This sphere encompassed in 2001 in Poland as many as 920 institutional units. Of these, 38% were research units, and 49% were enterprises. Out of the total number of 353 research units, 66% were constituted by the research-and-development entities, while 34% - by the universities. The universities, in which R&D activities was conducted, made up 35% of all the universities (344 in total).

Taking into account the fact that the enterprises, conducting the R&D activities, were as a rule industrial enterprises, their share in the total number of businesses active in industry was at the mere 0.2%.

At the end of 2001 the overall number of persons employed in the R&D activities (i.e. the fully employed and part-timers) was at 564,000, equivalent to 3.8% of the total employment in the country (14,988,000). Among those employed in this sphere 124,000 persons, for whom a given unit was the main employer, dealt to a varying degree with the R&D activities. They constituted around 22% of all persons employed in this sphere. The overall number of persons, dealing in a varying degree with the R&D activities, and so – devoting a varying amount of their work time to this activity, provided during the entire 2001 year 78,000 full time equivalents of their work, that is – 63% of the initial number of 124,000.

As we look at the dimensions of the R&D activities sphere in the light of the basic measures of the National Accounts, we can see that the global value (referred to in the nomenclature adopted for the System of National Accounts as global production) of the entire sphere of the R&D activities amounted to  $90 \cdot 10^9$  PLN and constituted 6.2% of the total global production in the country, while the share of R&D activities in the global value of this sphere amounted only to 4.9%, this share being equal 1.0% in the enterprises, and 15.5% in the public universities.

Another perspective on the dimensions of the R&D activities, conducted within the sphere considered, and their changes, may be constituted by the tracking of changes in the structure of full current expenditures of the institutional units belonging to this sphere.

The share of these expenditures on the R&D activities in the overall current expenditures of the units in question was also quite limited and, additionally, had a downward tendency.

There was a characteristic development of changes in the shares of these expenditures in the research-and-development units. In these units, which were classified in the enterprise sector, and so to a high degree (in some 50%) were financed from the non-budgetary sources, the share of expenditures on the R&D activities was higher than in the research-and-development units classified in the governmental sector, and thus financed to a much higher degree from the budgetary means (in 75% in 2001). In addition, in the latter, the share in question decreased in 2001 in comparison with the preceding year by as much as 6.9 percentage points (from 51.9% to 45.0%), while in the research-and-development units of the enterprise sector this share decreased only by 1.6 percentage point (from 59.6% to 58.0%).

Thus, the research-and-development units of the governmental sector, when regarded in the perspective of outlays borne, were busying themselves with the R&D activities to a lesser degree than the similar units classified in the enterprise sector. The latter ones, highly characteristically, were also to a lesser degree involved in the productive activity (in 2001: 30.7%), while those classified in the governmental sector had a higher share of expenditures on this activity (32.4%), with, however, the share of expenditures on the implementation lower by roughly 1/5.

In the light of the above statistical indicators the sphere of the R&D activities – as seen against the background of the entire national economy – presented itself in a less than modest manner.

## **R&D EXPENDITURES**

The R&D expenditures amounted in 2001 to 4.9·10<sup>9</sup> PLN and were by 4% higher than in the preceding year (in prices of 2000). In constant prices, of 1994, however, they decreased by 2.8%. The decrease (in prices of 1994) took place already in 2000, after four successive years of increases.

These expenditures, in constant prices, were lower by 5.1% than in 19891 and in 1999. Hence, if we refer to the constant prices of 1994, we observe in the recent years a distinct downward tendency in the outlays here considered.

When related to the Gross Domestic Product (GDP), the basic reference for determining the actual magnitude within the framework of the synthetic indicator of the country's development, these outlays displayed in the recent years significant shifts. The ratio, though, even if with certain fluctuations, had the tendency towards a significant decrease in the last one-and-a-half decade: from 1.31% in 19882 to 0.65% in 2001 – that is: by half.

The ratio of the expenditures on the R&D activities to the domestic capital expenditures (in current prices) displayed a similar direction of change. Since 1988, when this indicator value was 6.0%<sup>3</sup>, it was on the decrease, until the years 1998-2000, when it amounted to approximately 3.6%, and only in 2001 it slightly increased, reaching 4.0%, mainly due to the decrease of dynamics of the domestic capital expenditures.

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<sup>1</sup> Rejn B., *Nakłady na działalność badawczo-rozwojową w Polsce* [Outlays on Research and Development Activities in Poland], Z Prac ZBSE. Studia i Prace, z. 228, GUS Warszawa 1995

<sup>2</sup> See REJN, 1995, *op. cit.*

<sup>3</sup> Own calculations on the basis of data from B. REJN, *op. cit.*, and *Rocznik Statystyczny 1990* [Statistical Yearbook 1990], GUS Warszawa 1990

The capital expenditures into the R&D activities, decisive for the development of this activity, amounted in 2001 to 1.1·109 PLN and featured continuous fluctuations in terms of their share in the total of the domestic expenditures on the R&D activities. In the years 1994-1999, each drop of the share by a couple of percentage points in comparison with the preceding year, was followed by an increase. Then, in 2000 there was a repeated decrease, followed in 2001 by an increase. All these fluctuations have not been exceeding five percentage points, compared to the average share in these years equal 21.8% - and the higher one in 2001 by 1.3 percentage point (23.1%). These outlays, when compared to the domestic capital expenditures, displayed in the period considered essentially similar variations (between 1.1% in 1994 and 0.8% in 1998) as commented upon before, along the course of the same years, with exception of 1999, when no change with respect to the preceding year was observed, the decrease in 2000, and an increase in 2001 – for the same reason as specified before – to 0.9%.

The directions of investing in the R&D activities can be traced on the example of the changes in the structure of capital expenditures into this activity in the enterprise sector. Thus, within the enterprise sector the shares of particular directions of R&D activities in the capital expenditures into this activity featured characteristic changes, signalling the main preference for the directions identified with high and medium technology, and a limitation with respect to the directions of low technology.

The structure of current outlays in terms of nature of activities displayed over the recent decade and a half certain fluctuations, with, however, a definite tendency towards the increase of the share of expenditures on basic research – from 17% in 1985 to 35% in the years 1994-2001. The shares of the other two kinds of outlays had a decreasing tendency. The share of expenditures on applied research decreased from 33% in 1985 to 27% in the years 1994-2001, and into development work – from 50% in 1985 to 38% in the years 1994-2001. If, however, the share of expenditures on applied research had a downward tendency in the second half of the 1990s, and only in 2000-2001 started to increase slightly, the share of expenditures on the development work, after an increase in the second half of the 1990s, started to gradually decrease beginning with 1999. These tendencies clearly indicated the decreasing possibilities of experiencing a current impact from the output of the R&D activities on the national economy and differed essentially from the tendencies appearing in the economically developed countries.

The export of the R&D work output, as seen in the perspective of the outlays borne, was still marginal. The expenditures on this work, borne from the foreign sources, amounted namely in 2001 to only 2.4% of the domestic expenditures on the R&D activities, even though they were the highest since 1994. This share fluctuated as a sinusoid in the period 1994-1999 from year to year, though it continued to increase beginning with the year 2000. This particular share behaved in a similar way – in terms of frequency of fluctuations – similarly as the share of the capital expenditures in the total of domestic expenditures on the R&D activities, but the directions of fluctuations were opposite. Thus, when in a given year the share of the capital expenditures mentioned decreased, then the share of exports increased, and vice versa, when the share of exports decreased, the share of capital expenditures increased. Hence, the conclusion could be reached that perhaps the increase of the share of capital expenditures in a given year brought about an echo, delayed in time, in the form of increase of exports in the following year, this phenomenon taking place until 1999.

The expenditures on import of the R&D work, borne on the activities commissioned by the domestic units carrying out the R&D activities and executed abroad, constituting the so-

called external expenditures on the R&D activities, were incomparably lower than the ones borne on export of the domestic scientific and technological thought. These outlays, related to the export of the R&D work, ranged initially between 1/3 in 1994 and 3/4 in 1996. In the subsequent years this ratio decreased considerably, down to some 5% in 2001.

The outlays borne on import of research work were also marginal when compared to the domestic expenditures on the R&D activities. This ratio ranged from 0.5% in 1994 to 1.1% in 1996. In the consecutive years the values of this ratio oscillated around 1/2 percent, with a tendency towards gradual decrease, starting with 1997, and an abrupt collapse in the years 2000-2001 down to the mere 0.1%. This was the evidence of a gradual, and in 2000-2001 a sharp limitation of co-operation in this domain with other countries. The reasons should be sought first of all in the limited means for such kind of activity.

The global value of the R&D activities constitutes the basic measure for the Satellite Account for Research, linking financial expenditures on the R&D activities with the National Accounts System, in which it is referred to, as mentioned already, as global production. It encompasses current outlays (including amortisation) and its value in 2001 was 4.5·10<sup>9</sup> PLN – that is, in current prices, less than in the year 2000. The internal structure of this value underwent in the years 1994-1999 a change to the advantage of the gross added value (i.e. including amortisation), whose share increased by roughly 1/8 (up to 52%), to then decrease in 2000 down to 50%, and again to rise in the following year to 51%, the changes being primarily due to the relative increase or decrease of wages. During this period, therefore, the intermediate consumption would appropriately change, meaning the outlays on means and services purchased by the institutional units from the outside, for purposes of conduct of the activity in question.

The structure of intermediate consumption changed essentially, as well. And so, in particular, the share of external R&D service (external outlays) decreased in 2001 in comparison with 1994 by more than 2/5 (from 18% to 10%), meaning that the units have been curbing co-operation down to the necessary minimum. The share of expenses on purchase of specialised equipment decreased within the framework of intermediate consumption somewhat less, by 1/3, and it was equal 7% in 2001. Hence, expenses were on the decrease on the specialist equipment for research work, which was on the one hand associated with the general limitation of outlays, and on the other hand – with the limitation of expenditures on the specially costly studies of frequently highly novel character.

The gross value added of the R&D activities, constituted by the global value of this activity (current outlays) from which intermediate consumption had been deducted, amounted in 2001, similarly as in the preceding year, to 2.3·10<sup>9</sup> PLN. This newly created value in the domain of R&D encompasses, in view of the scope of the statistical reporting from the R&D activities, only the expenditures on labour and depreciation. The share of this value in the domestic gross value added was quite stable in the period 1994-2001 and oscillated around 0.4%, with a tendency towards a slight decrease in the first years of the current decade.

The biggest share in the gross value added was taken by the employee wages (including social security premiums). This share amounted in 1994 to 87%, though it decreased somewhat until 2001 (by roughly 5 percentage points) given the increase of amortisation rates.

The expenditures from the state budget, in the sector of Science, on the R&D activities, equalled in 2001 3·10<sup>9</sup> PLN. These expenditures, as related to the domestic expenditures on the R&D activities were quite stable and fluctuated in the years considered around the level of 3/5. In the period of 1994-1996 this ratio was virtually constant at roughly 62%, while in the

consecutive three-year period a tendency towards a slow decrease followed – down to 56% in 1999. Yet, beginning with 2000 there was a change in the tendency and an increase took place back to 62% in 2001.

## **R&D EXPENDITURES IN POLAND AS COMPARED TO OTHER COUNTRIES**

The R&D activities in Poland can be characterised against the background of other countries by, in particular, such synthetic measures as: relation of the financial expenditures on this activity to gross domestic product (GDP), the value of these outlays per capita, or per one research employee, as well as the internal structure of these outlays.

### ***Ratio of R&D Expenditure to GDP***

The R&D activities in Poland, characterised with respect to other member countries of the OECD through relation of the financial expenditures on this activity to the GDP value, has not essentially changed in the period considered. In the group of 29 countries, for which relatively comparable data are published, Poland took in 1994 – not being yet a member of the OECD – the 25<sup>th</sup> rank with this respect (0.78%), ahead of Mexico (0.29%), Turkey (0.36%), Greece (0.48% in 1993) and Portugal (0.63% in 1992). In 1999 Poland moved upwards (even though the ratio decreased down to 0.75%) to the 24<sup>th</sup> position, ahead of Hungary (0.69%) and Slovakia (0.68%), where the ratio decreased, as well, but behind Portugal (0.76%). One should add at this point that in the majority of the countries accounted for (in  $\frac{3}{4}$  of them) the ratio increased in this period. The ratio increased in various years of the 1990s in 20 countries and decreased in 9 of them. The data for 2001, available at the time of this writing, concern only 12 of these countries, which makes it impossible to present a broader analysis. Yet, we can state that among the OECD members considered the decrease in comparison with 1999 took place only in Norway, Poland, The Netherlands and Slovakia. This decrease amounted in Norway to 0.19 percentage points (from 1.65% to 1.46%), in Poland – to 0.1 p.p. (from 0.75% to 0.65%), in the Netherlands – to 0.05 p.p. (from 2.02% to 1.97% in 2000), and in Slovakia – to 0.01 p.p. (from 0.66% to 0.65%).

Among the OECD countries, which provide the respective data, the biggest increases of the ratio analysed – in comparison with 1994 – were as follows:

- more than two times over – in Iceland,
- by  $\frac{3}{4}$  to  $\frac{1}{2}$  - in Turkey, Finland and Mexico (in Finland by  $\frac{1}{2}$ ),
- by roughly  $\frac{2}{5}$  to  $\frac{1}{5}$  – in Greece, Austria (by approximately  $\frac{1}{4}$ ), Denmark (by  $\frac{1}{5}$ ), Spain, Czech Republic, United States,
- by roughly  $\frac{1}{8}$  to  $\frac{1}{10}$  – in Sweden, Belgium, Germany, Canada (by  $\frac{1}{10}$ ).

Among the 10 countries, in which this ratio decreased after 1994, the biggest decrease took place in Slovakia (by approximately  $\frac{1}{4}$ ), in Poland (by around  $\frac{1}{5}$ ), in Norway, United Kingdom, Hungary (by around  $\frac{1}{10}$  in each of them), and then in Iceland, France, Australia and Switzerland. The ratio increased only very slightly in the countries of the European Union – only by 0.05 percentage points, while in the OECD countries it increased by 1.5 p.p.

Among the other countries considered, there was an increase of the ratio by roughly 2/3 in China and Israel, and by around 1/3 in Russia, while there was a decrease in Romania and Slovenia, by roughly 50 and 12 percent, respectively.

It can be therefore observed that Poland was one of the last in the group of the OECD countries considered in terms of the ratio analysed. In addition, while in the majority of these countries the ratio increased, it decreased in Poland.

If we look at the internal structure of this ratio from the point of view of the contributions of main sources of finance, we can observe that among the 14 countries analysed Poland was 11<sup>th</sup> as to the contribution of the budgetary means. These means constituted in 2001 in terms of the ratio 0.42%, i.e. roughly 2/3 of the entire ratio, while the enterprise means constituted a bit less than 1/3 of the ratio. Hence, the contributions of these sources were in inverse proportions to those for all the member countries of the OECD.

### ***R&D Expenditure Per Capita***

The position of Poland among other countries of the OECD in terms of the magnitude of outlays borne on the R&D activities per capita of the inhabitants was less advantageous. In the group of 29 countries considered Poland was in 1994, with her 46 USD per capita (in current prices ppp), at 27th rank, the outlays per capita in Poland being roughly nine times lower than on the average in the OECD countries (415 USD) and around seven times lower than in the countries of the EU (335 USD). Poland was only ahead of Turkey (19 USD) and Mexico (21 USD). In 2001, despite a significant increase of these outlays in Poland (accounting also for the influence of shifts in currency exchange as well as the change in the conversion coefficient provided in MSTI No. 2002/2) – by 48%, compared to a much smaller increase in the countries of the OECD (by 29%) and in the EU (by 38% in 2000), the rank of Poland has not changed.

In all the countries considered there has been an increase of the per capita indicator in the years 1995-2001, in comparison with 1994. Among the countries having provided the respective data, and of special interest for Poland, the biggest increases of the value of the indicator analysed were as follows:

- more than two times: in Finland and Greece (until 1999),
- by more than factor of 1.5: in Portugal, Spain, Austria, Czech Republic and United States,
- by more than 1/3 in Ireland (by 49% until 1999), Germany, Norway and Hungary,
- by more than 1/4 in Japan and France.

Poland, with her 68 USD per capita, was ranked the last, 11<sup>th</sup>, in 2001 among the countries that provided the approximate data for that year.

### ***R&D Expenditure per Researcher***

The domestic expenditures on the R&D activities, calculated per one research employee were in 1994 in Poland the lowest among the 18 OECD member countries, which published the respective figures. In 1994 they amounted to 37 USD in current prices according to the purchasing power parity (ppp) and were lower by about 2/5 (43%) than in the analogous indicator for Hungary, the country that had, side by side with Portugal, the lowest value of the indicator in the group considered. In comparison with the countries of the European Union

these outlays were in Poland lower in 1994 by roughly  $\frac{3}{4}$  (by 76%), and in comparison with Switzerland, where these outlays were the highest in 1996 (225 USD) – they were lower by 84%.

Within the group of 18 OECD member countries, for which the ratio considered was calculated, Poland, having featured the increase of these outlays until 2000 by 13% (in constant prices) in comparison with 1996, took the 4<sup>th</sup> rank among the twelve countries, which displayed the increase of this ratio.

The highest increases of the expenditures considered were as follows:

- in Italy (by 33%), Turkey (by 26%), Czech Republic (by 23%), Portugal (14%), Poland (13%), South Korea (by 11%) and Finland (10%).

Attention, however, should be paid to the fact that from among the 18 countries considered six featured a decrease of the indicator in question. The deepest decrease took place in Slovakia (by 18%). In Switzerland the decrease amounted to 11%, in Spain – to 10%, in United Kingdom – to 7% in 1998, in Ireland – to 4% in 1999, and in France – to 3%.

So, expenditures on the R&D activities in Poland, related to the number of research employees were among the lowest in the group of the OECD member countries having published during the 1990s the comparable figures in this domain. This indicator, though, was on the increase in Poland in a significant manner.

### ***Comparison of the R&D Expenditure Structure***

Among the 14 member countries of the OECD (having a significant research potential or comparable with that of Poland), which provided the respective figures, Poland featured during the 1990s and in 2001 the highest share of expenditures on basic research. This share amounted in 2001 in terms of current expenditures on the R&D activities to 37.9%, while in other countries it ranged from 12% in 1993 in Ireland up to 37% in Czech Republic and 31% in Hungary – in 2000. In the countries featuring the highest research potential this share ranged between 12% in 1997 in Japan (in total outlays) and 18% in the United States. In the majority of the remaining countries (seven) this share ranged between 17% and 25%. Among the eleven countries, which provided the corresponding data in retrospective – in nine countries the share increased. This increase was most pronounced in the following countries: in Czech Republic – more than twofold increase between 1995 and 2000 (in total outlays), Poland – increase by roughly  $\frac{1}{5}$  between 1994 and 2001, Hungary – increase by  $\frac{1}{8}$  between 1995 and 2000, Portugal – increase by more than  $\frac{1}{10}$  between 1995 and 1999, France – increase by  $\frac{1}{10}$  between 1994 and 1999, and Italy – increase by roughly  $\frac{1}{20}$  between 1993 and 1998. There were three countries, in which the share of expenditures on basic research decreased: in Austria – by  $\frac{1}{5}$  between 1993 and 1998, in Japan – by around  $\frac{1}{8}$  between 1995 and 1999, and in Spain – by approximately  $\frac{1}{20}$  between 1993 and 2000.

In the light of the significant magnitude of the here considered share of expenditures on basic research in Poland, and assuming that it is actually the applied research and the development work that impact upon the national economy in a smaller or bigger degree and over a shorter or longer time horizon, it can be concluded that this impact was in Poland much smaller than in other countries considered.

The shares of expenditures on applied research ranged between 21% in the United States in 2000 and 46% Italy in 1998 (in total outlays), except for Sweden, where it amounted to only 15% in 1991. Poland, with her 26% of expenditures on applied research in 2001, was

ranked 11<sup>th</sup> among 14 countries. The lowest shares of these outlays were observed, as mentioned already, in Sweden, in the United States in 2000 (21%) and in Japan in 1999 (22%). The highest shares of these outlays (beyond 40%) were observed in Italy (46% in 1998) and in Portugal (40% in 1999).

Among the eleven countries, which provided the appropriate data in retrospective, eight featured a decrease of this share of outlays. This decrease was most pronounced in Norway between 1993 and 1999 – by roughly 1/8 (from 41.2% to 36.1%), while it amounted to approximately 1/10 in Poland between 1994 and 2001 (from 28.9% to 25.7%), in Hungary between 1995 and 2000, in Portugal between 1995 and 2000, and in Czech Republic (in total outlays) between 1995 and 2000. Hence, in these countries there has been a relative weakening of the inflow of the research and technological thought to the economy, as seen in the perspective of this share of outlays. There were three countries, in which this share increased: in Italy the increase between 1993 and 1998 amounted to more than 1/8 (from 40.4% to 46.1%), in Austria between 1993 and 1998 the increase amounted to 0.8 percentage points, and in Spain, between 1993 and 2000 – to 0.2 p.p.

The shares of expenditures on development work, that is – into the activity aiming at practical use of the results of applied research – ranged in the majority of the countries considered (altogether nine) between 36% and 53%. It was only in Portugal in 1999 and in Czech Republic in 2000 that this share remained at about 32%. In three highly developed countries this share attained 60-65%. These countries were Sweden (the share equal around 65% in 1991), United States (61% in 2000), and Japan (60% in 1999). Poland, featuring the share of outlays on the development work amounting in 2001 to 36.4%, was close to the lower bound of the range of values observed, ahead of Portugal (31.8% in 1999) and Czech Republic (32.5% in 2000).

Among the eleven countries, which provided appropriate retrospective data, an increase of this share was observed in seven countries. The most pronounced increase was observed in Hungary between 1995 and 2000 – by more than 1/4, in Austria, between 1993 and 1998 – by more than 1/5, and in Norway between 1993 and 1999 – by roughly 1/8. This share (related to total outlays) increased in Japan between 1993 and 2000 by about 1/10, while in Spain, between 1993 and 2000 – by 0.8 percentage point. There were five countries in the group considered, in which the share in question decreased. The decrease was the most pronounced in Czech Republic – by about 1/3 and in Poland - by 1/20.

Thus, the position of Poland among the countries considered was in terms of this indicator also quite disadvantageous, and this fact was yet compounded by the decrease of the indicator's value.

In the light of the here reported structure of expenditures on the R&D activities the inflow of the scientific and technological thought to the economy was in Poland marginal and yet displayed a decrease.

Financial outlays in Poland spent on the R&D activities, as seen in the perspective of the share indicators here considered, placed Poland at one of the last places among the OECD member countries, having provided appropriate figures.

The ratio of the outlays to the number of research employees showed an upward tendency in the last years of the decade of the 1990s, but in 2000 this ratio slightly decreased.

The structures of financing sources supporting the R&D activities, as well as the structures of the kinds of activities conducted, were in Poland disadvantageous, when seen in a comparative setting, and yet displayed a tendency toward worsening of these structures, which

had undoubtedly a negative impact on the inflow of the scientific and technological thought to the economy.

## **SOURCES OF R&D FINANCING DURING 1994-2001**

The internal sources of financing of the R&D activities in 2001 were mainly (roughly in 2/3, that is – in 65%) the state budget, with the share of means from this source displaying an upward trend in the second half of the 1990s. The second source of financing of this activity (in more than 1/5, that is – exactly 23%) were own means of the units conducting the activity. The means from this source have also been on the increase until 1999 (by more than 1/4, up to 28%), but then in the years 2000-2001 decreased below the level from 1994. The third, significant source of financing was constituted by the enterprise means (9%), they decreased, though, by roughly 1/3. The remaining sources of financing had a marginal character, and so: the means from abroad constituted 2.4%, of the units belonging to the Polish Academy of Sciences and the research-and-development units – 0.3%, from the private non-profit organisations – 0.3%, and of the universities – 0.2%.

The data that we have at our disposal are given in current prices, and thus do not account for price changes. Such changes were therefore established on the basis of differences resulting from the comparison of the institutional sources of financing in 2001 and the analogous structures as of 1994.

The comparison of these structures yields the following image of changes in the sources of financing of the outlays borne by the institutional units:

The financing of the expenditures on the R&D activities from the primary source, constituted by the state budget – the former State Committee for Scientific Research, as well as other ministries, increased in the years considered by more than 1/10 (from 58.2% to 64.8%). Until 1999 there has been a significant increase in the financing of these outlays from the second source, constituted by own means of the units belonging to the R&D activities sphere. This increase, namely, amounted to more than 1/5 (from 23.4% to 28.3%), but in 2001 a decrease followed below the level from 1994 – down to 22.8%. In terms of dynamics there has been the most pronounced increase of financing of this activity from foreign sources – almost twofold until 2001 (from 1.3% to 2.4%). This source, however, as can be easily concluded from the data quoted, had only a marginal significance. The remaining sources of financing decreased in importance significantly. Thus, the third source as to the volume of financing constituted by own means of enterprises, disbursed on the R&D work, commissioned with other institutional units, decreased by about 1/3 (from 13.7% to 9.2%). The decrease was most pronounced in case of the marginal sources of financing, constituted by the commissions to conduct the R&D work by the research units of the Polish Academy of Sciences and the research-and-development units (from 2.0% to 0.3%) as well as universities (from 1.1% to 0.2%). Thus, these two sources decreased by approximately 4/5. The share of the private non-profit institutions decreased by 1/4 and amounted to 0.3%.

Capital expenditures for R&D activities were financed in 2001 mainly (in 95%) from the state budget (in 58%) and own resources of the units conducting the R&D activities (in 37%). There has been, though, a significant differentiation of means originating from these two kinds of sources across the sectors. Thus, while the enterprise sector financed its investments mainly from its own means (in 81%), and only in 17% from the budgetary means, the situation was quite opposite in the remaining main sectors. And so, the governmental sector

financed its investments in 66% from the budgetary means, and only in 19% from own means. Further, the university sector financed its investment undertakings in 89% from the budgetary means, and only in 10% from own means.

Hence, the primary sources of financial support for the particular sectors' investments resulted from their institutional structure. Other sources of means for the capital expenditures had a marginal character

### ***R&D Financing in Main Economy Sectors***

From among three significant sectors (according to OECD) of the sphere of the R&D activities it was the university sector that took the most of the budgetary means spent (more than  $\frac{2}{5}$  in 2001). The share of this sector increased in comparison with 1994 by more than  $\frac{1}{4}$  - from 34% to 44%. The second sector, in terms of the share considered (around  $\frac{2}{5}$ ) was the governmental sector, though its share had a decreasing tendency during the period in question (by altogether  $\frac{1}{10}$ , from 43% to 39%). The enterprise sector was financed from the budgetary means in a proportion two times lower, absorbing roughly 17% of the means, this share having in the period considered significantly decreased (by  $\frac{1}{4}$  - from 23% to 17%).

The entities belonging to the enterprise sector disbursed the most from their own means among the sectors of the R&D activities sphere, namely as much as 81%. This share amounted in 1994 to 71%, so that the relative increase exceeded  $\frac{1}{8}$ . The units belonging to the governmental sector disbursed from their own means only 12%, that is – by about  $\frac{3}{5}$  less than in 1994 (28%). The universities spent in 2001 from their own means 6.3%, that is – more than four times the share from 1994 (1.5%).

The resources of the enterprises, spent on the R&D work commissioned by the formal executors to other institutional units, were used to the greatest extent (in some  $\frac{3}{5}$ ) by the remaining units of the enterprise sector, mainly (in 98%) by the research-and-development units. Yet, the share of this sector gradually decreased in the period analysed. It decreased by 2001 in comparison with 1994 by roughly  $\frac{1}{8}$  (from 69% to 60%). There was, on the other hand, a significant increase (by  $\frac{1}{2}$ ) of the share taken in these means by the units of the governmental sector (from 12% to 18%), and also an increase – by about  $\frac{1}{5}$  – of the share taken by the university sector (from 19% to 22%). It should, however, be noted that while the share of the governmental sector displayed with this respect an increasing tendency over the years in question – significantly curbed only in 2001 – the shares of the university sector decreased at the end of the 1990s (from 27% in 1998 to 24% in 1999).

Foreign resources were primarily consumed by the units of the governmental sector, although the share of this sector in the use of these means somewhat decreased (from 57% to 56%).

Hence, the budgetary means, distributed in more than  $\frac{4}{5}$  (86%) by the former State Committee for Scientific Research, were primarily – and virtually equally – consumed and spent by the university sector (more than  $\frac{2}{5}$ ) and the governmental sector (around  $\frac{2}{5}$ ). While, however, the share of the first of these sectors increased in the second half of the 1990s (from about  $\frac{1}{3}$ ), the share of the governmental sector decreased by approximately  $\frac{1}{10}$ .

### ***Sources of R&D Financing in Main Economy Sectors***

The enterprise sector, holding, as mentioned already, the largest, but starting with 1999 gradually decreasing, share in the domestic outlays, was financed to the highest degree (in roughly  $\frac{1}{2}$ ) from its own means. The units of this sector, carrying out the R&D work, financed

from their own means, in 1994, 42% of the internal costs borne, and by 2001 increased this share to 52% (that is – by  $\frac{1}{4}$ ), although in 1999 this share was even higher and amounted to 60%. If we take into account own means of units carrying out the R&D work and the means of the other units of this sector, commissioning the execution of the R&D work in their own sector, then we can observe, that the enterprise sector used its own means in 1994 in 65.3%, and in 2001 increased the share of these means in total outlays of the sector merely to 67.2%, although in 1999 this share amounted to 72%. During the same period, though, the share of the second biggest source of financing of this sector, that is – of the budgetary means – has been decreasing. These means, namely, covered in 1994 33% of the outlays borne, while in 2001 – 30%, although in 1999 their share dropped to 27%, i.e. by  $\frac{1}{5}$ . Foreign means have not played any significant role in the outlays of this sector, but their share increased twice (from 0.9% to 1.8%).

There was a characteristic lack of any changes in the structure of sources of financing of this sector between the years 2000 and 2001.

The research-and-development units, classified in this sector, made use to a large extent of the budgetary means. The share of these means was, in addition, increasing. Thus, in 1994 it amounted to 44% of the expenses into the R&D activities, while in 2001 it attained already 51%, having increased by more than  $\frac{1}{8}$  (although having also slightly decreased in comparison with 1999 – by 0.5 percentage points). The means of enterprises, directed to these units, were systematically decreasing in relative terms: from 31% in 1994 to 24% in 2000, that is – by roughly  $\frac{1}{4}$ , although they have increased again in 2001 to 28%. The outlays paid from own means of the units considered remained until 2000 at more or less the same level of 22%, but in 2001 they decreased to 18%. There was, at the same time, a significant rise in the share of outlays paid from the foreign sources, namely by more than  $\frac{2}{3}$  (from 1.3% to 2.2%), but this share remained still marginal.

The changes in the sources of financing of the R&D activities took quite a different course in the enterprises. The share of own means increased, namely, in this period by approximately  $\frac{1}{5}$  (from 79% to 92%), while the share of the budgetary means decreased by about  $\frac{1}{2}$  (from 11% to 6%). Thus, the financing of the R&D activities carried out within the enterprises from the state budget shrank considerably, while the role of own means became overwhelming. One can also notice a significant, deepening decrease of co-operation between the enterprises. If in 1994 the share of other enterprises (ordering parties) in the expenditures on the R&D activities, conducted in the enterprises actually carrying it out, amounted to 9%, by 2001 it dwindled to the mere 0.6%, i.e. by more than  $\frac{9}{10}$ . There was, on the other hand, a more than six-fold increase of the share of foreign means of financing (from 0.2% to 1.3%), remaining, however, just a margin, and in 2001 not having increased in comparison with the preceding year.

The governmental sector founded the financing of its R&D work, of course, on the means from the state budget, whose share increased, in addition, by roughly  $\frac{1}{5}$  (from 70% to 81%), although it somewhat decreased in the recent years preceding the year 2001 (from 80% 1998 to 78% in 2000). During the period in question there has been a significant decrease of the share of own means of this sector by approximately  $\frac{1}{2}$  (from 18% to 9%). This sector was taking to an increasing degree advantage of the means originating from the enterprises. The share of these means increased, namely, significantly until 2000 (from 4.6% to 8.8%, that is – almost twice), but in 2001 it dropped to 5.2%, remaining at an altogether low level. There was, on the other hand, an essential decrease of the means from other units of this sector (the research units of the Polish Academy of Sciences and the research-and-development units).

This share declined by more than 9/10 (from 4.5% to 0.3%). Finally, the share of means from the universities persisted at a very low level – both in 1994 and in 2001 it amounted to 0.2%.

The research units of the Polish Academy of Sciences based their activity, quite understandably, on the means from the state budget, whose share increased during the period in question by more than 1/8 (from 77% to 88%). At the same time there was a decrease of the shares associated with such sources of financing as the research-and-development units (from 11.0% to 0.3%), private non-profit institutions – by 2/3 (from 1.1% to 0.4%), as well as own means – by about ¼ (from 7.7% to 5.7%). Simultaneously, there was an increase of the share of means from the enterprises. The inflow of financial means from this source, even though quite limited, displayed an increasing tendency. And so, the share of the enterprises increased by more than 2/5 (from 1.4% to 2.0%), although it decreased by 1/8 in comparison with 1999, when it amounted to 2.3%. Besides, there was a significant increase of the small share of foreign means (by roughly 4/5, from 1.8% to 3.2%), and of the means from the universities (from 0.2% to 0.3%).

The sector of educational institutions was mostly using the means from the state budget (approximately 9/10 of the outlays). The share of these means has had, in addition, a tendency towards a slight increase (from 82% to 87%). The second significant source of financing of the R&D activities conducted were the means of the enterprises, which, however, dropped by about 2/5 (from 10% to 6%). There was also a decrease, by half, of the already marginal share of means from the research units of the Polish Academy of Sciences and the research-and-development units (from 0.4% to 0.2%). On the other hand, the share of foreign means increased by more than 2/5 (from 0.9% to 1.3%). The co-operation between universities had a marginal character and yet significantly decreased. The share of the outlays financed by other universities dwindled during the time considered almost completely (from 4.0% to 0.2%).

The enterprise sector, the largest one in terms of outlays borne into the R&D activities, was financed with this respect in half from own means, and in 1/3 from the state budget. It should be noted that the former share has been increasing, while the latter – decreasing. The university sector was financed in more than 4/5 from the state budget, this share displaying a slight, but progressing increase.

The governmental sector was also predominantly financed from the budgetary means, the share of these means having significantly increased (from 70% in 1994 to 81% in 2001, that is – by 1/6).

### ***Sources and Uses of R&D Expenditures in Enterprise Sector***

The enterprise sector, as mentioned, was the largest sector in the sphere of the R&D activities in terms of the magnitude of internal outlays in the domestic outlays on the R&D activities (36% in 2001, i.e.  $1.7 \cdot 10^9$  PLN). Within this sector, in 2001,  $0.9 \cdot 10^9$  PLN were spent from own means on the R&D activities – that is, more than 4/5 (81%) of own means of all the institutional units of this sphere, disbursed for purposes of the R&D activities.

Own means of the units classified in this sector, constituted, as indicated, the main and increasing (until 1999) source of financing of particular directions of the R&D activities. The increase mentioned brought the share up from 42% in 1994 to 60% in 1999, meaning the shift by more than 2/5, followed, though, by the decrease in 2001 to 52%. This source of financing was to the greatest extent used for the R&D activities concerning Manufacture of machinery and equipment. The expenditures on this direction of activity amounted in 1994 to 18% of the total internal outlays in the sector, and increased until 1999 to 22%, that is – by more than 1/5,

although they decreased in 2001 to 19%. The second direction of the R&D activities in terms of this share was Manufacture of pharmaceutical products, the respective share having increased from 5.0% in 1994 to 6.4% in 1999, in order to then reach 10.2% in 2001. The third direction was production of Manufacture of motor vehicles, trailers, and semi-trailers, its share having increased until 1999 twofold (from 8% to 16%, although it dropped in 2001 to 8%). The fourth direction of activity, which had a significant (around 8% in 2001) share in the outlays of this sector, financed from own means, was Telecommunications. The share of this direction significantly increased (from 2.8% in 1994 to 7.5% in 2001, that is – 2.5 times).

The budgetary means were used to the highest extent in 2001 for the R&D work oriented at Manufacture of chemicals and chemical products. The share of the budgetary means consumed within this direction of the R&D activities in the total outlays from the budgetary means borne in this sector on the R&D activities, remained in 2001 at the level from 1994 and amounted to 8.8%. The second direction of the R&D activities with this respect was the one encompassing Manufacture of machinery and equipment. The share of this direction, though, decreased by around 1/10 (from 9.4% in 1994 to 8.4% in 2001). The third was the direction oriented at production of electronic elements. Its share increased by approximately 1/10 (from 7.5% to 8.1%).

In relative terms, the greatest increase of financing of the R&D activities from the state budget took place in the direction encompassing production and supply of electricity, gas, steam and water, namely 23 times (from 0.1% to 2.3%). There were also significant increases in the directions encompassing transport and storage – more than three times (from 0.8% to 2.5%), national defence – twofold (from 3.5% to 7.0%) and Manufacture of pharmaceutical products – by more than 4/5 (from 0.6% to 1.1%).

The financing from the third significant source of means, constituted by the means of (other) enterprises, essentially declined. The share of these means dropped by more than 1/3 (from 24% in 1994 to 15% in 2001).

When observing the changes in the shares of the budgetary means in the internal outlays of the particular directions of the R&D activities, we can state that they increased in 12 directions, which is not equivalent to stating that the financing from the budget actually increased in these directions. The share of the means from the state budget could namely increase in view of the decrease of own means or means from the enterprises. The increase of this share was observed in the following directions:

- more than sevenfold – in production and supply with electric power, gas, steam and water (from 4.3% to 31.5%);
- by 3/5 to 2/5 – in Manufacture of textiles (from 38% to 61%), transport and storage economy – by about 1/2 (from 20% to 30%), production of electronic elements – by 2/5 (from 60% to 85%), Mining of coal and lignite; extraction of peat – by 2/5 (from 46% to 67%);
- by more than 1/3 – production of precious and non-ferrous metals (from 47% to 64%), production of the transport equipment other than mechanical vehicles, aircraft, and vessels (from 24% to 33%);
- by around 1/5 to 1/8 – Manufacture of chemicals and chemical products (from 33% to 38%), Manufacture of medical, precision, and optical instruments, watches etc. (from 17% to 20%), Manufacture and repair of ships and boats (from 44% to 52%), Manufacture of rubber and plastic products – by 1/8 (from 14% to 15%).

There were 14 directions of the R&D activities, in which a decrease of the share of means disbursed from the state budget took place, accompanied by a significant increase of the share of own means of the executing units, and a decrease of the means from (other) enterprises. The biggest decreases of the share of means from the state budget were as follows:

- by roughly 2/5 to 1/2 - Manufacture of coke, refined petroleum products and nuclear fuel (from 23% to 15%), production of aircraft and spacecraft (from 62% to 36%), Telecommunications (from 37% to 22%), production of food products and beverages – by 1/2 (from 40% to 21%), construction – by 1/2 (from 50% to 26%), production of iron and steel – by 1/2 (from 39% to 20%);
- by more than 1/4 to 1/5 – Manufacture of pharmaceutical products (from 8% to 5.7%), national defence – by 1/4 (from 79% to 60%), Manufacture of machinery and equipment – by 1/5 (from 22% to 18%), Manufacture of motor vehicles, trailers, and semi-trailers – by 1/5 (from 8.3% to 6.9%).

The above trends in the shares of the budgetary means used up for financing of definite directions of R&D activities, similarly as in the preceding year, do not provide an unequivocal evidence for the preference as to particular directions of this activity. We mean here potential orientation at production of the so-called hi-tech products and medium tech products, or curbing of production of medium-low technology or low technology products. Yet, some elements of such orientation can certainly be traced.<sup>4</sup>

### ***R&D Financing Sources in Poland vs. Other Countries***

During the last decade changes took place – sometimes quite important – in the structure of sources of financing for the R&D activities in all the countries selected for consideration in the present report. A significant part of these countries conducted the policy of increasing the share of the enterprise means in the domestic expenditures on the R&D activities, this share constituting the primary source of means for the R&D activities. Consequently, this share increased in the member countries of the OECD in the years 1994-2000 by approximately 1/10. There are, however, some countries, in which a decrease of this share could be observed. These were, in particular, Poland, Czech Republic, Austria and Canada. In Poland and in Czech Republic the share of these means decreased by roughly 1/4: in Poland between 1994 and 2001 from 38.7% to 30.8%, while in Czech Republic between 1995 and 2001 from 63% to 53%. The decrease in Austria amounted to approximately 1/8 (from 46% in 1994 to 39% in 2001), and in Canada – to 2 percentage points between 1994 and 2001 (from 44% to 42%). In the group of countries considered there has been the most pronounced relative increase of the share of enterprise means in Spain – by more than 1/5 (from 40% in 1994 to 50% in 2000). There has been a somewhat smaller increase of the share of these means in Finland and in the United States. In Finland the increase amounted to approximately 1/4 - from 57% in 1993 to 70% in 2000, and in the United States it amounted to roughly 1/5 (from 59% in 1994 to 68% in 2001). A significant increase of this share – namely by around 1/10 – could also be observed in France between 1994 and 1999 (from 49% and 54%), though in 2001 it decreased to 52.5%.

The means from the state budget constituted the subsequent as to importance source of financing of the R&D activities in the majority of countries. Among 17 countries considered,

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<sup>4</sup> See Rejn B., Żółkiewski Z., *Działalność B+R w okresie transformacji - nakłady, źródła finansowania, efekty* [R&D Activities during Transformation – Expenditures, Financing Sources, Results], Z Prac ZBSE. Studia i Prace, z. 267, GUS Warszawa 2000

only in four these means exceeded  $\frac{1}{2}$  of the domestic expenditures on the R&D activities. These countries were as follows: Portugal (70% in 1999), Poland (65% in 2001), Russia (55% in 2000) and Italy (51% in 1996). In the remaining countries the shares of these means ranged between roughly  $\frac{1}{5}$  in Ireland in 1997 (22%) and approximately  $\frac{1}{2}$  in Hungary in 2000 (49.5%).

The increase of the share of these means took place in the second half of the 1990s in just a couple of countries: in Czech Republic – by more than  $\frac{1}{3}$  (from 32% in 1995 to 44% in 2001), in Portugal (by about  $\frac{1}{20}$  (from 65% in 1995 to 70% in 1999), and in Poland. These means increased in Poland in 2001, in comparison with 1994, by around  $\frac{1}{10}$  (from 58.2% to 64.8%).

Foreign means constituted in the countries considered a small fraction of the domestic expenditures on the R&D activities. The highest share of these means was observed in 2001 in Austria, where it also increased in the years 1994-2001 by the factor of 4.5 – from 4% to 19%. A high share of these means could as well be observed in Canada in 2001 (16%), while a pronounced increase of the share of these means took place in the years 1994-2000 in Hungary (threefold increase). There were only three countries, in which a decrease could be observed in this period in terms of the share of these means: in Portugal - by more than  $\frac{1}{2}$  (from 12% in 1995 to 5% in 1999), in Spain – by around  $\frac{1}{4}$  (from 6.4% in 1994 to 4.9% in 2000), and also in Israel (from 4.4% in 1995 to 3.8% in 1999). In Russia, after an increase of this share more than eight times over between 1994 and 1999, a decrease followed in the subsequent years by approximately  $\frac{1}{2}$ .

Among the countries of Central and Eastern Europe, belonging to the group here considered, the highest share of these means was observed in Hungary—it amounted in 2000 to 10.6% and increased almost threefold in comparison with 1994 (3.7%). In Czech Republic, as well, the share of the foreign means increased in the second half of the 1990s (from 3.3% in 1995 to 4.0% in 1999m that is – by around  $\frac{1}{5}$ ), but it decreased in the following years to 2.2% in 2001. The share of these means in Poland was low in comparison with the remaining countries considered, and it amounted to 2.4% in 2001, having, however, increased by more than  $\frac{4}{5}$  in relation to 1994.

It can therefore be stated that the main source of financing of the R&D activities in 2001 – displaying, in addition, a tendency towards increase – was constituted in eleven out of 17 countries considered by the means of the enterprises. The subsequent significant source of financing of the activity in question was the state budget, although the shares of these means were in the majority of the countries observed decreasing. In Poland, on the other hand, the budgetary means were the main source of financing the expenditures on the R&D activities, and they were increasing. Foreign means constituted a marginal share in the vast majority of the countries observed (13), except for Austria, Ireland, Canada and Hungary. These means had a definitely marginal position in Poland.

Summing up the changes in the sources of financing of the R&D activities, which took place in the second half of the 1990s and in 2001, we can state that this activity was financed in Poland primarily and in the increasing degree (in roughly  $\frac{2}{3}$ ) from the budget. This constituted a clear difference between Poland and many other member countries of the OECD, in which an opposite situation was observed. The means from the state budget were in Poland in 2001 used to the highest degree in the university and governmental sectors (approximately  $\frac{2}{5}$  in each of them), although the tendencies in these two sectors were opposite: an increase in the governmental sector and a decrease in the university sector.

The second source of financing of the R&D activities (in more than 1/5) was constituted by own means of units conducting this activity. The share of means from this source had been increasing in the second half of the 1990s, but in the current decade it started to decrease again.

The present report made use mainly of the statistical data from the Division of Science and Technology of the Department of Economic Statistics, Central Statistical Office (GUS).

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