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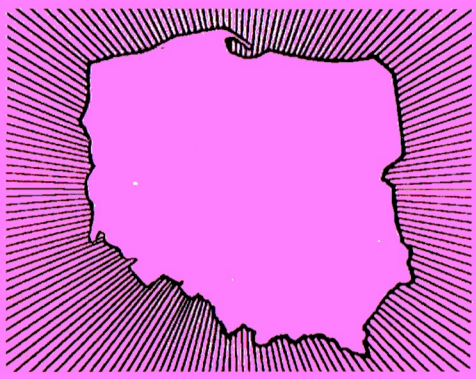

Bohdan Jałowiecki
Janusz Hryniewicz
Agnieszka Mync

Ucieczka mózgów

z nauki i szkolnictwa wyższego w Polsce w latach 1992–1993

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The Brain Drain
from Science and Universities in Poland, 1992–1993

Bohdan Jałowiecki
Janusz Hryniewicz
Agnieszka Mync

Warsaw 1994

EDITORS OF THE SERIES:
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Antoni Kukliński
Grzegorz Gorzelak
Bohdan Jałowiecki

Editor of the volume: Bohdan Jałowiecki

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Address: University of Warsaw
European Institute for Regional and Local Development
ul. Krakowskie Przedmieście 30, 00-927 Warszawa
Tel. 26-16-54; 20-03-81 ext. 643, 748
Telex 825439 UW PL, Fax 26-75-20

Table of Contents

Introduction

This volume is the second publication of the European Institute for Regional and Local Development during the past two years on the brain drain from science and higher education in Poland. The State Committee for Scientific Research (KBN), encouraged by the results of the previous report, passed the resolution in which it recommended to conduct the study every two years. The report published in 1992 met with great interest by the press. The problems analyzed in the publication were widely discussed by the dailies and periodicals. Its authors gave a dozen or so interviews in the press, on TV and on the radio.

The report published by EUROREG also aroused great interest abroad. The Regional Office for Science and Technology for Europe (UNESCO-ROSTE) in Venice made a financial contribution to the Conference on transformation of science in Central Europe from the point of view of the brain drain. The Conference was attended by a number of specialists dealing with this subject, and its results were published in English[1]. One of the authors of the report presented a paper based on the report at the international seminar organised by UNESCO-ROSTE in Venice in April 1993. The paper was published in the proceedings of the seminar[2]. It was also summarised in one of the leading French geographical periodicals[3].

The present report is an implementation the KBN resolution regarding the periodic study of the brain drain from science and higher education. The analyses presented in the volume are not simply a repetition of the study conducted in 1992. The questionnaire was supplemented

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[1] *Report of the International Seminar: "Transformation of Science in Poland: Brain Drain Issues"*, UNESCO-ROSTE, Venice 1993.

[2] J. Hryniewicz, B. Jałowiecki, A. Mync, R. Szul, *Brain Drain in the Period of Transition*, Proceedings of the International Seminar on "Brain Drain Issues in Europe", UNESCO-ROSTE, Venice 1993, pp. 56–97.

[3] J. Hryniewicz, B. Jałowiecki, *La fruite des cerveaux en Pologne*, „Géographie et culture", nº 8/1993, pp. 17–32.

by several new questions, and the interviews with university rectors and heads of other research institutions were attached.

The authors wish to express thanks to all the heads of academic and research institutions who sent the answers to their questionnaire as well as to the persons interviewed who devoted their time to the questionnaire.

The authors also want to express their hope that their findings will stir public opinion once again and will contribute, at least partly, to the improvement in the situation of Polish science and higher education.

1. Brain Drain in the Global Perspective

The phenomenon of brain drain has been of concern for international organisations, UNESCO in particular, which have investigated it for many years now. According to its data, in the years 1961–1979 some 600,000 specialists migrated from the so-called developing countries. They usually settled in the USA (about 60%), Canada (about 20%) and Great Britain (about 15%). Since the early 1970s the number of migrants has been growing and it is estimated at some 50,000 persons per annum. Beginning with 1975, the value of the transfer of human resources has also been estimated. This data shows that in the years 1961–1972, the immigration of specialists caused that the United States gained some 34 billion dollars, Canada — some 12 billion dollars, and Great Britain — 5 billion. **Thus, only these three countries gained some 50 billion dollars due to the transfer of a highly skilled labour force.**

In the years 1961–1976 the three above-mentioned countries absorbed 61,000 physicians, 100,000 engineers and 120,000 other technical workers, who supported the economy of the highly advanced countries.

The flight of intellectual labour occurs in two forms: direct migration or finding a permanent job after graduation in a given country. The motives for this flight are evident and stem from the difference in potential between the developed and the developing — as they are kindly referred to — countries. Emigres in Western countries are attracted by higher salaries, better working conditions, stabilisation and political freedoms, as well as the possibility of educating children in the best universities. In recent years, the major causes of migration include ethnic wars, lack of political stabilisation in many countries, and religious fundamentalism, particularly the anti-scientific Muslim fundamentalism.

Another factor attracting migrants is the rapid expansion of research and development (R&D). Opportunities for scientific employment are incomparably better in these countries than in the home country. It is interesting that out of the 85,000 doctoral degrees conferred in the USA in the years 1960–1982, as many as 55,000 were granted to migrants.

Thus, the home countries of the migrants finance the education of specialists, which is expensive in the case of a university. Therefore, their migration to another country is an investment failure from the point of view of the country that had educated them. The majority of migrants are young people: 49% of intellectual migrants coming to the USA are under 30 years of age, and the further 46% are aged 30–44[4].

In countries where the brain drain is very high, migration, which causes a permanent shortage of highly skilled staff, especially in the universities and in the research centres of these countries, virtually precludes reproduction of the highly qualified personnel.

In order to prevent this, the developing countries often employ specialists from highly advanced countries, thus bearing a disproportionately high costs. For example, in 1992 the university of Harare (Zimbabwe) faced a shortage of 30% of teaching staff, and Makerere University in Uganda was short of 48% of its personnel[5].

Obviously, the benefits go to the developed countries since they receive well-educated specialists and do not need to bear the cost of their education. It was estimated that only in the USA 15–20 new medical colleges should be opened in order to educate the indispensable number of physicians and nurses if the migration of the kind of specialists ceased.

In the early 1990s, this world market of intellectual labour was fed with migrants from the post-communist countries. The brain drain also occurred in the previous period, but it was limited due to administrative barriers. Despite those limitations, several million people migrated from the former communist countries in the 1980s, including a high percentage of specialists with university degrees. Thus, out of 184,000 Jews who moved in 1990 from the USSR to Israel some 39% had university degrees. In the years 1980–1987 some 70,000 specialists and 10,000 students left Poland (including 47,000 engineers and technicians, 3,000 physicians, 4,800 economists and some 4,000 academic and research staff)[6].

The "Universal Declaration of Human Rights" of 1948 (art. 13, paragraph 2) signed by the majority of countries, as well as the "International Pact of Citizen's and Political Rights" state that an individual has an unrestricted right to leave his (her) country. On the other hand, the "Declaration on the Right to Development" passed by the United Nations General Assembly in 1986, includes the following wording:

[4] *Le probleme de l'exode des compétences: causes, conséquences et remedes et rôle de l'UNESCO a cet égard,* UNESCO 1987.

[5] P. Williams, *Academic Mobility and the Brain Drain,* UNESCO 1992.

[6] B. Rhode, *East-West Migration/Brain Drain,* COST, Commission of the European Community, Brussels 1992.

1. *The right to development is an inalienable human right by virtue of which every human person and all peoples are entitled to participate in, contribute to and enjoy economic, social, cultural and political development in which all human rights and fundamental freedoms can be fully realised.*
2. *The human right to development also implies the full realisation of the right of peoples to self-determination, which includes, subject to the relevant provisions of both International Covenants on Human Rights, the exercise of their inalienable right to full sovereignty over all their natural wealth and resources.*

However, the society's right to development is somehow in contradiction to the individual's right to leave his country, since migration entails the impoverishment of its development potential. This contradiction involves a long-standing dilemma of the relationship between the individual and society. The UNESCO experts suggest the following solution:

- *The brain drain is a barrier to the realization of the right of society to development;*
- *The political, civil, economic, social and cultural rights of the individual and society constitute an indivisible entity of human rights. Since they constitute an entity, they may only be realized as entity;*
- *The individual has not only rights but also duties to society (state);*
- *Thus, the migrations of the citizens from the country, as well as immigration of foreigners, should be rationed in a scientific way in order to avoid discrimination in this field*[7].

The question arises immediately: what does it mean to "ration" and what is the "scientific way"?

The moral and ethical complexity of mutual relationships between the society and individual is also contained in the "Universal Declaration of Human Rights", which includes the following wording (art. 29):

> *Everyone has duties to the community in which alone the free and full development of his personality is possible. In the exercise of his rights and freedoms, everyone shall be subject only to such limitations as are determined by law solely for the purpose of*

[7] Cf. note 4.

securing due recognition and respect for the rights and freedoms of others and of meeting the just requirements of morality, public order and the general welfare in a democratic society.

Like all noble declarations of this kind, the Declaration, which tries to reconcile immanent controversies of social conditions of human beings, is unfortunately of no major importance and will not deter or even limit global economic processes which contributed to unequitable development and caused and continues to cause brain drain from one region to another.

The limitation of migration from any country is extremely difficult. The application of administrative barriers is expensive from the social point of view and is of little effect. As the experiences of the communist countries show, migration was present all the time, though its intensity varied. On the contrary, administrative restrictions counteracting migration are an additional and often main motivation for leaving. Moral and patriotic appeals as well as reminding of the obligations towards society (and state) do not yield visible results either.

The only effective way of hampering migration of specialists from the less developed countries is the opening of the economy, its internationalisation and joining the global processes of the world economy. The countries involved should enter the international market of intellectual labour through a gradual raising of the salaries on domestic markets to reach the world market level. They should also try to compensate for the losses caused by the outmigration of own specialists by employing scientists from other countries. As shown by the experiences of many countries, internationalisation of the economy and attraction of big corporations expands the labour market, including the intellectual labour market, thus leading to a rapid growth of salaries.

In Central and East European countries, including Poland, branches of big corporations are now being established. They are taking advantage of a relatively cheaper labour force in this region as well as of a huge and absorptive market. These firms also expand the intellectual labour market. Many foreign firms keep seeking highly skilled specialists in various disciplines. These enterprises include such big corporations as Rhône-Poulenc, Sandoz, Whirlpool, Erickson, Procter & Gamble, Seagram and Sony[8].

[8] Cf. the results of the studies of the European Institute for Regional and Local Development on the intellectual labour market, [in:] J. Hryniewicz and B. Jałowiecki, *Rynek pracy intelektualnej w Polsce (The Intellectual Labour Market in Poland)*, EUROREG, Warszawa 1994.

The demand on the Polish intellectual labour market has already exceeded supply, particularly in modern kinds of services for enterprises, banking, finances, information as well as in some technical specialisations. So far, this market has been fairly chaotic and divided into segments. On the one hand, there exists a real market in which qualifications are sold at prices slightly approximating their value, though being well below European prices. On the other hand, there is a quasi-market encompassing public enterprises (not including the boards of directors of state treasury companies) and the so-called "budgetary sphere" (science and higher education in particular), a real relic of communism, where the price for the labour force is arbitrarily fixed by the state bureaucracy, with no relation whatsoever to the level of skills.

As a result, intellectual workers are absorbed from the quasi-market, which is being deprived of the most highly skilled and youngest specialists. The magnitude of this internal brain flight is much larger than the external one. The two kinds of the drain from science and higher education seriously limit the possibilities of reproduction of the staff with university education in Poland and in other Central and East European countries, thus decreasing their development capacity.

In the report on the brain drain published in 1992 we have introduced an important terminological distinction by stating that the term drain suggests, on the one hand, a conscious activity of the countries which attract research staff from other countries, and that, on the other hand, this term is charged with strong ideological undertones. Therefore, we think that the term "brain flight" has a more descriptive nature; at any rate, it is more adequate for Polish conditions.

2. Methods of Investigation

The methods of investigation take into account both Polish specificity and recommendations of the UNESCO conference regarding the brain flight from Central and East European countries held in Venice in November 1991. Its proceedings stressed that the focus should be on the brain flight from the selected scientific disciplines: biology, informatics, economics and physics (Task Force Meeting). The Polish specificity consists of extremely high absorption of researchers by other sectors of the national economy.

The sample was limited for financial reasons so the authors decided, just as in the case of the previous study, to make use of the questionnaire mailed to all research institutions selected for investigation. In 1994 the scope of the study was extended to encompass all the university centres (in the previous inquiry only eight largest educational and scientific centres were examined: Warsaw, Cracow, Wrocław, Poznań, Lublin, Katowice, Gdańsk and Łódź). In particular academic centres, the study encompassed universities, except for the academies of physical education, higher schools of arts, police, firemen's and military academies, as well as theological academies and departments. On the other hand, all the institutes of the Polish Academy of Sciences have been taken into consideration. Besides, the study comprised ministerial institutes carrying out scientific research. The so-called development units, design offices, libraries, archives and scientific societies were not investigated. The selection of the units was based on the Directory of Polish Science. As a result, the sample was composed of 2300 institutes, autonomous departments, chairs, etc.

All these research institutions received the questionnaire aimed in the first place at registering the phenomenon of the brain flight to foreign countries as well as to other sectors of the economy. The questions regarding the employment of new scientists and financing of the units were added to the questionnaire mailed in 1994. All in all, the study encompassed 1043 academic and research units (compared to 1003 in 1992) em-

ploying 30,588 scientists (in 1992 — 28,497). This allowed us to present in detail the structure of employment of Polish science according to the centres, institutions, magnitude of units and academic disciplines.

The study conducted in 1994 was remarkably enriched with 19 interviews with university rectors of Upper Silesia, Cracow, Lublin, Łódź, Poznań, Rzeszów and Warsaw, with the secretaries of several divisions of the Polish Academy of Sciences and with directors of the ministerial institutes. The interviews present the picture of the situation in the particular universities, thus permitting a better understanding of the effects of the brain flight upon the functioning of the particular units and a more in-depth interpretation of statistical data obtained in the questionnaire.

3. Science and Higher Education in Poland in the Early 1990s

3.1. The financing of science and higher education

The outlays on science and higher education in Poland in the early 1990s amounted to about 1.5% of GDP including 0.6%–0.7% on science itself[9]. They were much lower than in such developed countries as the United States, Germany or Japan, where this figure is nearing 3%. The difference is slightly smaller in the case of France and Great Britain, where research and development receive some 2.5% of GDP. A similar level of outlays can be found in Italy[10].

The first years of the present decade are characterised by a well-marked stabilisation of state science and higher education policies reflected in the diminishing rank of these spheres in the economy of the country. Since 1991, their share in budgetary expenditures has systematically declined: in the case of science from 2.4% to 1.7% in 1994, and in the case of higher education from 2.8% to 2.1% (see Table 1). A similar level of expenditures on science, disregarding the crisis of the 1980s, occurred in Poland in the second half of the 1970s.

Most financial means allocated to science and higher education are distributed by three institutions[11]: Ministry of National Education, State Committee for Scientific Research and Polish Academy of Sciences. The Ministry finances primarily the didactic activity of the higher schools, while the means of the KBN are mainly designed to finance and

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[9] *Założenia polityki naukowej i naukowo-technicznej państwa. Cele, priorytety, finansowanie* (Dokument rządowy przyjęty przez Radę Ministrów na posiedzeniu w dniu 20 lipca 1993 r.), Komitet Badań Naukowych, Warszawa, July 1993, p. 15.

[10] Cf. A. H. Jasiński, *Struktura i tendencje państwowych wydatków na B+R w wybranych krajach (Structure and Trends of Government Expenditures for R&D in Selected Countries)*, „Zagadnienia Naukoznawstwa", No. 2(106), 1991, pp. 310–311.

[11] Cf. *Ustawa budżetowa na rok 1994 z dnia 25 marca 1994 r. (Budgetary Bill for 1994 of March 25, 1994)*, Dz. U. No. 52, item 209.

Table 1

Structure of state budget current expenditures according to selected sectors of the national economy in Poland in the years 1981–1994

Sector	1981	1985	1990	1991	1992	1993	1994[1]
	as a percentage of total current expenditures						
Science	1.2	0.9	0.2	2.4	1.8	1.8	1.7
Education and upbringing	7.5	9.5	12.8	11.6	10.3	10.2	9.2
Higher education	.	2.1	3.6	2.8	2.7	2.6	2.1
Culture and arts	1.1	1.7	1.8	1.0	0.8	0.7	0.7
Health and social care	8.6	11.6	19.0	22.0	22.0	20.8	18.4
Physical culture, sports, tourism and recreation	0.3	0.5	0.6	0.4	0.1	0.2	0.2
State administration, justice, public prosecution and safety	4.0	6.3	7.9	7.9	8.2	9.1	7.5
Finances and social insurance	5.9	12.2	16.6	25.0	35.2	37.3	39.2

[1]Total expenditures planned in the Budgetary Law for 1994.

Sources: *Roczniki statystyczne* (*Statistical Yearbooks*), GUS, Warszawa, various annual editions; *Mały rocznik statystyczny 1994* (*Small Statistical Yearbook 1994*), GUS, Warszawa 1994, p. 289; *Ustawa budżetowa na rok 1994 z dnia 25 marca 1994 r.* (*Budgetary Bill for 1994 of March 25, 1994*), Dz. U. Nr 52, item 209 and own calculations.

co-finance the statutory activity of the scientific, research and development units as well as research by institutions of higher education, and next to finance research projects. The Committee also supports scientific cooperation with foreign countries.

Institutions of higher education may also acquire means from the budgets of the local authorities, donations, payable research activity, charges for some lectures and classes[12], economic activity etc[13]. These sources make it possible to slightly supplement finances of the universities.

[12] For example, in 1993 in the University of Warsaw the number of students charged for instruction (evening, extramural and postgraduate studies) totalled 30%. The charges ranged from 1.5–2 million zlotys to 17.5 million zlotys per one semester.
Source: *Sprawozdanie roczne Rektora Uniwersytetu Warszawskiego złożone na posiedzeniu Senatu Uniwersytetu Warszawskiego w dniu 11 maja 1994 r. (The Annual Report of the Rector of the University of Warsaw Submitted to the Senate of the University of Warsaw on 11 May, 1994).* Warszawa 1994, p. 9.

[13] *Ustawa z dnia 12 września 1990 r. o szkolnictwie wyższym (The Bill of 12 September, 1990, on Higher Education),* Dz. U. No. 65, item 385; *Rozporządzenie Rady Ministrów z dnia*

Other sources of financing the R&D activity are more and more frequent, too, though their importance has so far been marginal. These funds come from state-owned and private enterprises, foundations, private colleges[14] as well as — to a small extent — from foreign assistance, mainly from the international organisations.

The Western sources have not met our expectations. In the interview published in "Gazeta Wyborcza" Professor Witold Karczewski, chairman of the KBN, said: *The money we have received from the various Western sources did not exceed 2% of the funds allocated to science from the state budget*[15].

The extra-budgetary way of financing science and research is just being shaped, and the whole system is quite different from the models occurring in highly advanced countries with a market economy (see Figure 1).

The opinions regarding the level of growth of outlays on science from the state budget cause disagreement among the politicians and scientists. According to the Ministry of Education, the stabilisation of the situation in higher learning itself would require the increase of outlays to reach 1% of GDP till 1997. According to the opinion of the rectors of universities expressed in their letter sent in May 1994 to the state authorities, these outlays ought to amount to 2.5% already by 1996[16].

3.2. The number, dynamics and structure of the population of academic and research staff

In 1994 in Poland there were some 400 units of the sector S&T as well as more than 140 higher schools. They employed a total of over 200 thousand persons, of whom one-third fell to science and two-thirds — to higher education.

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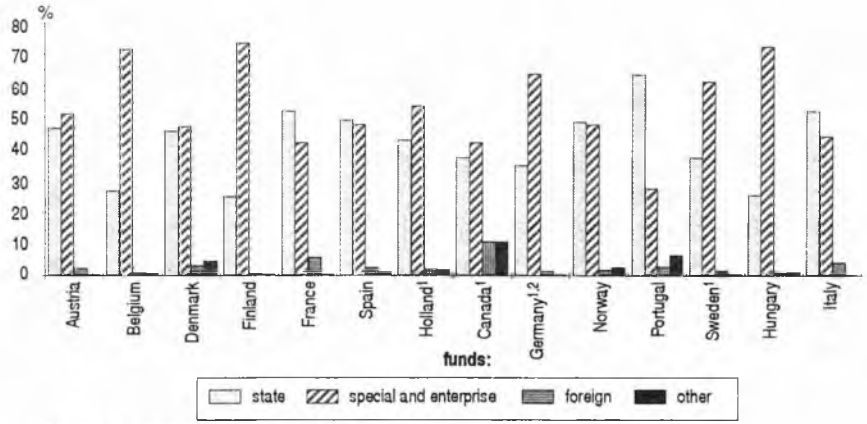
27 sierpnia 1991 r. w sprawie zasad gospodarki finansowej uczelni (Decree of the Council of Ministers of 27 August, 1991, on the Principles of the Management of the University Finances), Dz. U. No. 84, item 380, and No. 112, item 485.

[14] The academic year 1993/94 began in 40 non-public schools of higher learning, including 7 schools of various denominations (e.g. the Catholic University of Lublin) and 31 schools run by the international foundations, associations and private persons (e.g. the French-Polish Higher School of New Techniques in Information and Communications in Poznań, Private Higher School of Business and Administration in Warsaw or Higher Business School — National Louis University at Nowy Sącz).

[15] *Nauka i polityka (Science and Policy)* — The interview with Professor Witold Karczewski, chairman of the State Committee for Scientific Research, „Gazeta na Salon", extra edition of "Gazeta Wyborcza", September 1994.

[16] *Zdaniem Rektora (In the Rector's Opinion).* The statement of the Rector of the University of Warsaw, Professor Włodzimierz Siwiński, "Uniwersytet", No. 6, May 1994.



[1] Excluding social and human sciences; only production sector
[2] West Germany only

Fig. 1 Sources of financing R&D works in selected countries in the late 1980s, as a percentage of total means

The population of the research staff totalled some 63 thousand persons, the majority of whom (over 80%) were the employees of higher schools. About 19% were employed in scientific-research units, of which almost 12.5% accounted for ministerial and branch institutions, and slightly more than 6% — for the Polish Academy of Sciences. In the units servicing science and technological development only 100 persons held scientific jobs, that is less than 0.2% of the entire population.

Since the beginning of the 1990s, the number of science staff has decreased by 4%, that is 2,500 persons, most of whom worked in ministerial and branch units. There has been a considerable drop in staff numbers too in the institutes of the Polish Academy of Sciences. On the other hand, in higher education the situation has stabilised in respect of the existing potential. Between 1992 and 1993 the number of research staff slightly increased (Figure 2).

The decrease of the population of research staff was largely caused by the restructuring of the R&D sector as well as by the extreme reduction of the research and development activities due to economic weakness of the big industrial enterprises. Other factors, particularly limitations in the financing of science, will, however, continue to make people leave research jobs. Compensation for the losses in quality may appear to be unfeasible, even though the quantitative compensation occurs.

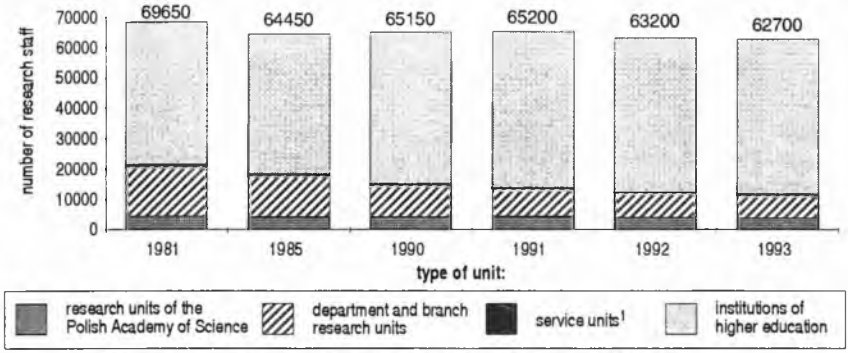


Fig. 2 Research staff in Poland in the years 1981–1993 according to types of scientific units

Another disadvantageous phenomenon for the functioning of science and higher education — apart from decreasing number of research staff — is a decline of total employment in these spheres. This entails reduction of the number of auxiliary workers, including engineering, technical, economic, and managerial employees, as well as librarians and documentalists performing the tasks related to research and teaching as well as to the management of research units and institutions of higher education. The number of the employees in this group has fallen in recent years by about 20%. This must have affected the course and quality of research and teaching processes. Besides, the situation is difficult due to great fluctuations in this category of staff.

The problem of "excess" employment in the sphere of science which has often been discussed in literature[17] has a relative character and does not manifest itself unambiguously against a background of other countries (Figures 4 and 5).

It can only be noticed that in respect of the number of research staff and engineers per 10,000 population, Poland in the 1980s was outpaced by such highly advanced countries as West Germany, Great Britain, Finland, but it outpaced Holland, Denmark, Italy and Austria. In respect of the structure of the scientific-technical employees, as divided into research staff and engineers as well as technicians, there was a slight difference between Poland and Italy. There is also a certain similarity

[17] Cf., for example, J. Kozłowski, *Nauka i technika w Polsce w świetle liczb (Science and Technology in Poland in the Light of Figures)*, KBN, Warszawa, December 1992, p. 4.

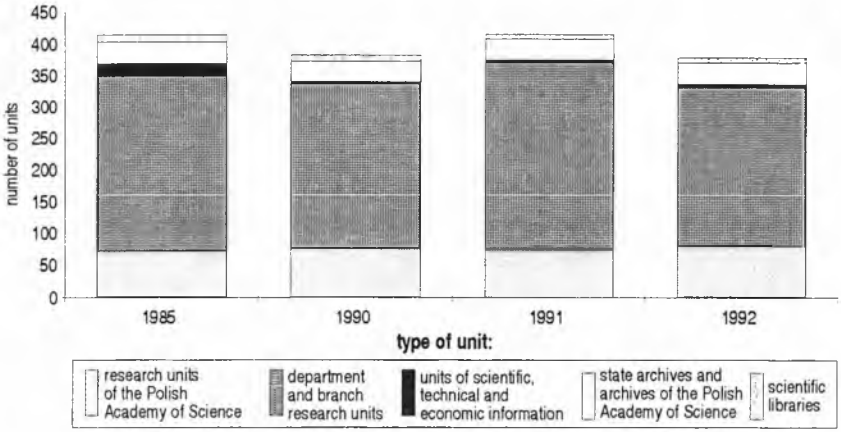


Fig. 3 Units in the sector of "science and technological development" in Poland in the years 1985–1992

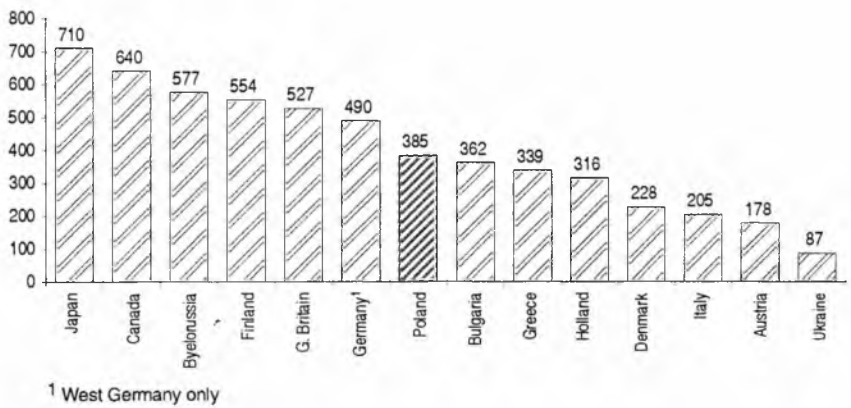


Fig. 4 Research staff and engineers per 10,000 population in Poland and in selected countries in the 1980s

to this structure in Denmark and Holland. However, in making such comparisons, one must take into account differences in classification and the way of data presentation.

Likewise, the estimates regarding the number of university instructors are relative. For example, the ratio of the number of students per one academic teacher in Poland in the 1980s was comparable to the ratio in West Germany. In recent years, however, significant changes have

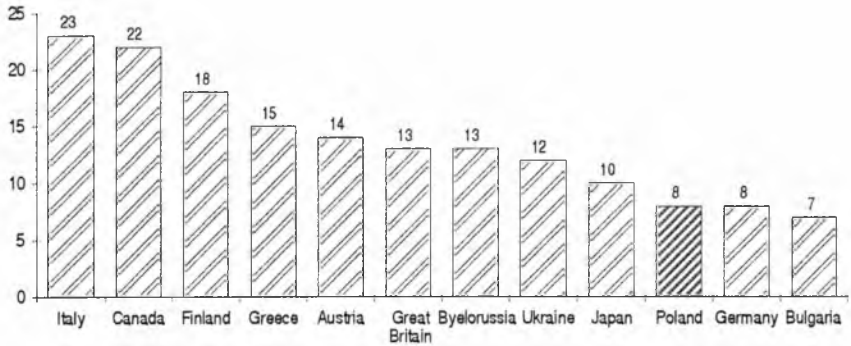


Fig. 5 Number of students per 1 academic teacher in Poland and in selected countries in 1980s

occurred in Poland. Along with the increasing number of students and relatively stable number of academic instructors, 11 students are falling to one teacher now, while in 1990 this ratio equalled 8. In some universities the increase was even higher, e.g. in the University of Warsaw the ratio rose from 8 to 17[18].

The structure of qualifications of the research staff in the 1990s was subject only to small fluctuations (cf. Table 2). The percentage of professors and assistant professors amounted to 22%, while the percentage of adjoint professors and assistants totalled 78%. However, significant changes occurred in comparison with the early 1980s, when this proportion was 17% to 83%. The number of professors rose by 19% in that period, while the number of the younger staff fell by 16% (in the years 1990–1993 by nearly 5%). In 1993, 35 adjoint professors and assistants fell to 10 professors, while in 1981 — 49. **This testifies to the progressing deformation of the structure of qualifications in Polish science.**

This observation is also confirmed, at least partly, by the analysis of scientific degrees and titles conferred over the past 13 years (Figure 6). Generally speaking, in comparison with the previous decade, the 1990s have seen a decrease in the number of doctor's degrees conferred, while the number of professors with doctor's degrees has been increasing. As regards the case of professors, there has been no clear-cut tendency, although in the 1990s more titles have been granted each year than in the 1980s. In all categories, there was a sudden fall in nominations in 1991.

[18] *Sprawozdanie roczne rektora Uniwersytetu Warszawskiego... (The Annual Report of the Rector of the University of Warsaw...),* op.cit., p. 8.

Table 2

The structure of population of research staff[1] in Poland, according to posts occupied in the years 1981–1993

Years	Professors[2]		Assistant professors		Lecturers[3], senior assistants, assistants	
	absolute figures	percentage	absolute figures	percentage	absolute figures	percentage
1981[4]	3,799	5.5	8,004	11.5	57,835	83.1
1985	4,185	6.5	7,506	11.7	52,548	81.8
1990	5,834	9.0	8,073	12.4	51,229	78.6
1991	8,632	13.2	5,927	9.1	50,642	77.7
1992	10,091	16.0	3,823	6.0	49,288	78.0
1993	Professors and assistant professors				48,700	77.7
	absolute figures		percentage			
	14,000		22.3			

[1] 1985 and 1990 full-time employees, 1981 and 1991–1993 including part-time employees in terms of full-time employees; yearly averages excluding 1981; since 1991 full-time employees employed in more than one higher school are listed at each working place.
[2] Since 1991 including persons without scientific title professor employed in higher schools on the professor post.
[3] ad juncts.
[4] As of December 31.

Sources: *Roczniki statystyczne* (*Statistical Yearbooks*), GUS, Warszawa, various annual editions; *Nauka polska w liczbach 1985–1990* (*Polish Science in Figures 1985–1990*), GUS, Warszawa 1992, p. 10 and own calculations.

Interesting observations can be made while analyzing the scientific titles and degrees in the particular disciplines (Figures 7–9). Most titles and degrees were conferred in social sciences: in the case of professors from 32% to 39% of the total number, professors with a doctor's degree — from 30% to 33%, and doctors — from 23% to 32%. In agricultural sciences this number is at its lowest, ranging from 8% to 13%. As regards the dominant position of the social sciences, there were two exceptions: in the first half of the 1980s more doctoral theses were written in technical sciences, and in the years 1991–1992 — in medicine.

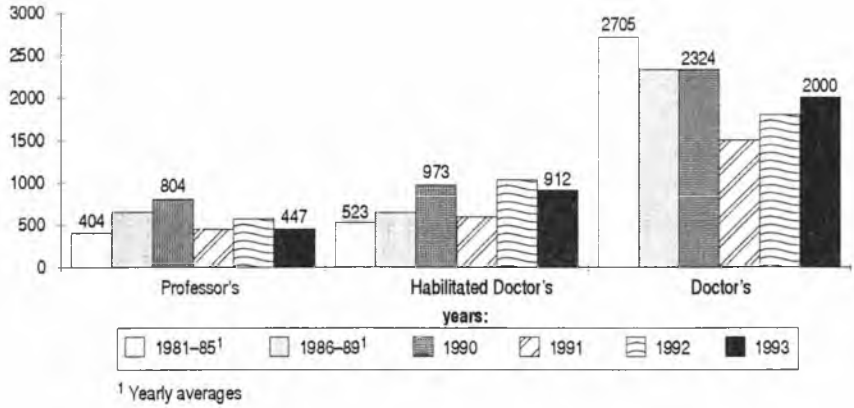


Fig. 6 Scientific titles and degrees conferred in Poland in the years 1981–1993

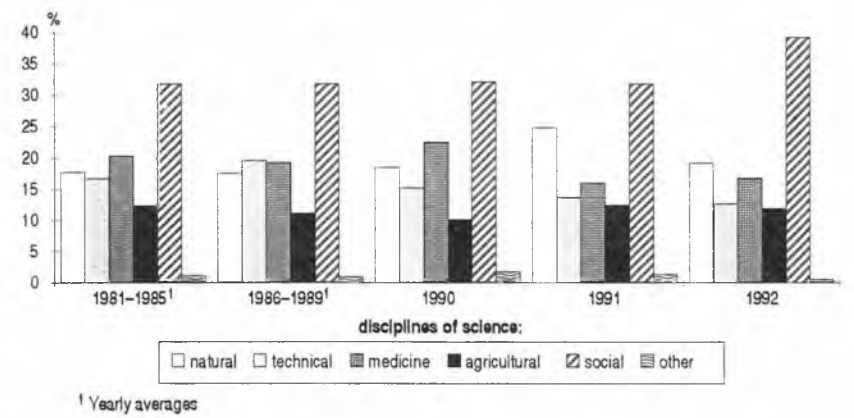


Fig. 7 The structure of scientific titles of professors conferred in Poland according to disciplines of science in the years 1981–1992

In the 1990s, as compared to the 1980s, the number of the titles of professors almost doubled in all disciplines and the number of the professors with PhD rose by 1.5 times (except for medicine, which showed a decline). However, the number of new PhDs (except for medicine) considerably decreased: from 20% in agricultural sciences to 40% in technical sciences.

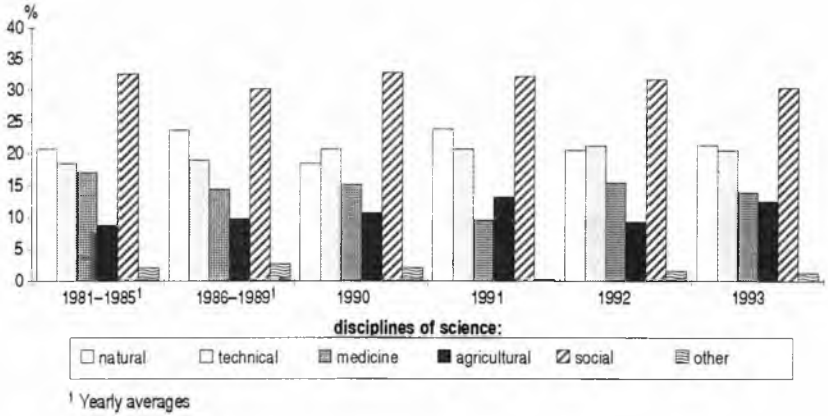


Fig. 8 The structure of scientific degrees of habilitated doctors conferred in Poland according to disciplines of science in the years 1981–1993

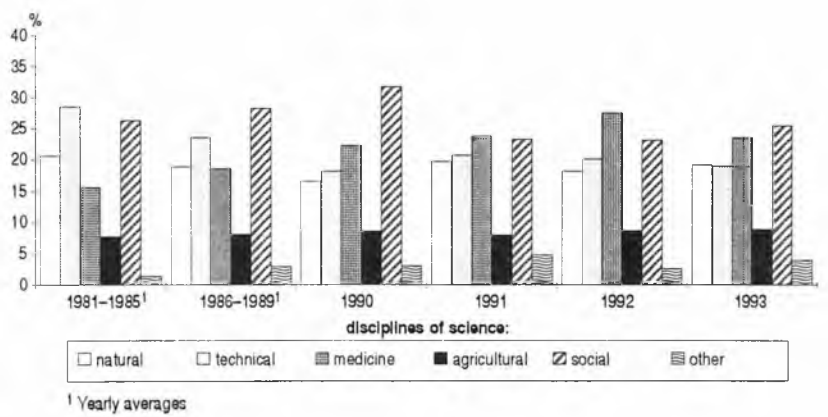


Fig. 9 The structure of scientific degrees of doctors conferred in Poland according to disciplines of science in the years 1981–1993

3.3. University education

In the academic year 1993/94 the number of students in Poland exceeded 580 thousand persons, including 395 thousand intramural students. As compared to the early 1980s, this number increased by more than 28% (see Table 3). This is mainly due to increased university enrollment in recent years.

Table 3

Characteristics of university education in Poland in the years 1980–1994

Specification	1980/81	1990/91	1991/92	1992/93	1993/94
Number of higher schools	91	112	117	124	141
Students, in thous.	453.7[1]	403.8	428.2	495.7	581.6
previous period = 100	x	89.0[1]	106.0	115.8	117.3
Graduates[2], in thous.	84.0[1]	56.1	59.0	61.4	64.1
previous period = 100	x	66.8[1]	105.2	104.1	104.4
Teaching staff, in thous.	54.7	64.5	63.2	63.0	65.6
previous period = 100	x	117.9	98.0	99.7	104.1

[1]In the academic year 1980/1981 excluding students and graduates of the higher schools subordinated to the Ministry of National Defence and the Ministry of the Interior. Therefore the index number does not necessarily reflect the real drop in number in the years 1980–1991.
[2]Graduates in the years: 1980, 1990, 1991, 1992 and 1993.

Source: *Mały rocznik statystyczny 1994* (*Small Statistical Yearbook 1994*), GUS, Warszawa 1994, p. 161 and own calculations.

Thus, the ratio of students per 10,000 population improved. Between 1990 and 1993 it rose from 106 to 151, but the gap between Poland and the highly advanced countries of Western Europe is still great (cf. Figure 10).

The level of dissemination of higher education in the relevant age groups has been disadvantageous, too. In 1991, 21.5% of youth studied in Poland, while in Austria, Belgium, Spain, West Germany and Sweden — from 34% to 36%, in Holland — 38%, In France — 43%, in Norway — 45%, and in Finland almost 51%.

In the 1990s, the number of graduates in Poland has been increasing, although this rise is much slower than that of the number of students (cf. Table 3). In 1993, the number of university graduates amounted to 64,000 persons, 14% higher than in 1990. However, the graduates in 1993 constituted only some 75% of persons completing studies in the early 1980s. The situation looked similar in other countries, for example in Finland, Sweden or Hungary.

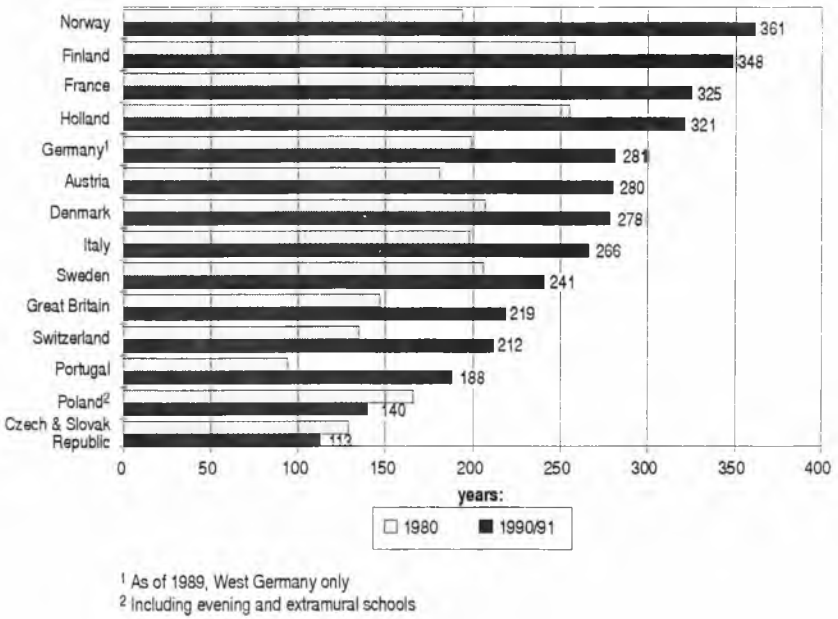


Fig. 10 Students of academic education in Poland and in selected countries in 1980 and in the early 1990s per 10,000 population

The universities play the most important role in higher education, as they concentrate almost 37% of students and their significance is rapidly growing (Figure 11). As compared to the early 1980s, the number of university students rose by 63%. At the same time, the technical universities have lost in importance as the number of their graduates decreased by half. However, the first years of the current decade show that this trend is likely to be reversed.

As regards the remaining types of higher schools, the most characteristic is the expansion of the business schools, where between the academic years 1990/91 and 1993/94 the number of students increased by 120%. This stems from the increased demand for these specialists in the market economy. There was a certain rise in the number of students of pedagogical schools (by 40%), which is due to growing requirements in relation to the teachers. In medical schools, on the other hand, the number of students declined by 20% due to the surplus of physicians.

Most students in Poland study the human sciences, then come the technical disciplines. In the academic year 1993/94 students of these di-

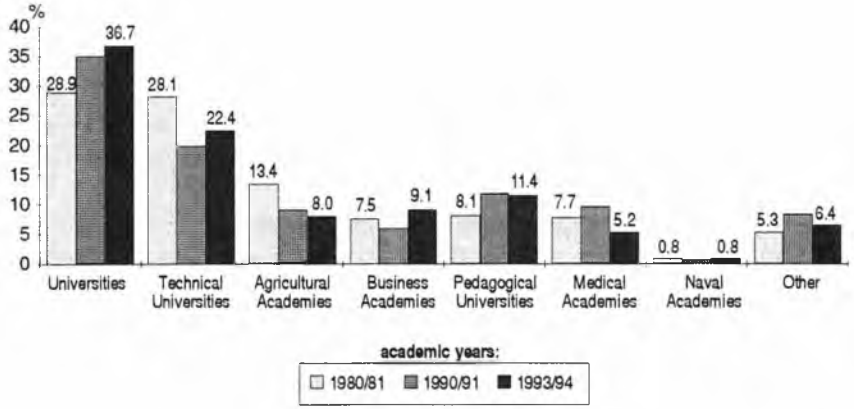


Fig. 11 Share of students of various types of academic education in the total number of students in Poland in the years 1980–1994

rections constituted 26% and 22% respectively (cf. Figure 12). The human disciplines recorded more than 29% of graduates, and technical — almost 18%.

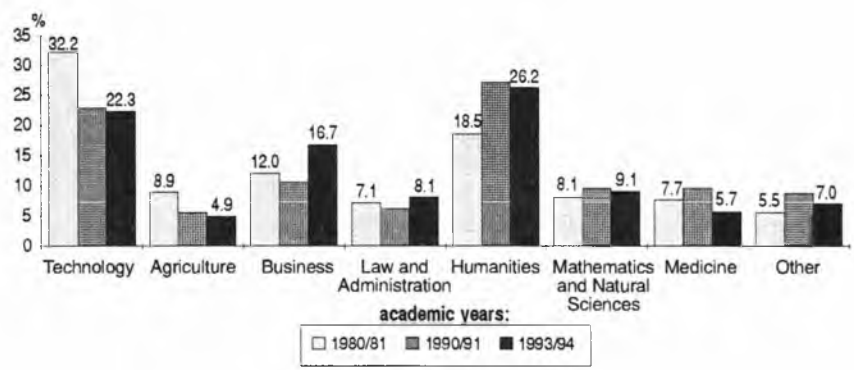


Fig. 12 Share of students of the broad field of study in the total number of students in Poland in the years 1980–1994

In comparison with the early 1980s, the importance of the human disciplines increased. The ratio of students rose by 8 percentage points, and of graduates — by 10 points. The trend was reversed in the case of technical sciences, where the share of students fell by 10 percentage points and that of the graduates — by 12 points. The reorientation

of interests has also been observed in the case of other directions of the study. The increasing interest in the economic studies as well as in law and administration is worthy of attention. On the other hand, the position of the agricultural sciences has declined. The declining trend of the number of students of medicine, which has decreased by 15% since the beginning of the 1990s, is quite alarming.

The comparison of the structure of higher education in Poland with the structure in other countries based on the classification of sciences used by UNESCO is shown in Tables 10 and 11 in appendix.

In the analyzed group of countries it is interesting to note the differences in the importance of law and social sciences as well as technical sciences. At the turn of the 1980s and 1990s, in the majority of countries (including Poland) the students of the first group prevailed, and the differences between the particular countries were notable: from 17% of students of law and social sciences in Hungary to over 45% in Spain. In countries where the domination of this group was quite clear in the early 1980s, its position strengthened (e.g. in Austria — increase from 31% to 39%, in Spain — from 33% to 45%, in Switzerland — from 28% to nearly 41%, or in Italy — from 30% to 43%. In Poland, on the other hand, between 1980 and 1991 the importance of these directions (according to UNESCO classification) slightly decreased, which confirms our previous observations.

In some countries in the early 1990s the students of technical directions have still dominated, e.g. in the Czech Republic and Slovakia (jointly) — 34%, or in Bulgaria — 31%. This is the heritage of the education model patterned after the former Soviet Union. In Russia in 1991 this ratio amounted to 44%. However, in these countries, too, this model already belongs to the past. In some of them, the share of the students of technical sciences declined by 5–10 percentage points between 1980 and 1991.

As regards medical studies, their importance decreased — similarly as in Poland — in the majority of European countries (cf. Tables 10 and 11 in appendix).

3.4. Material situation of the units and of research staff

As indicated in the 1992 report, the material situation of research institutions and of their employees was bad, and the persons interviewed described this situation as dramatic. **In the past two years, the financial**

condition of science and institutions of higher education has further deteriorated; besides, the differences between the units and particular scientists have deepened.

The material situation in the spheres of R&D and higher education consists of the following elements: employees' salaries, financial means for research, scientific-research equipment, housing and technical conditions, supply of the world literature of the subject etc. The objective measurement of these elements (which are hardly comparable) and construction of the relevant synthetic indicator is virtually impossible, therefore one must make use of partial information. The information available includes the data on the costs of research work (Table 4 and Figure 13). However, it should be borne in mind that their level is largely affected by the kind of research conducted, for example the difference between experimental studies and studies not requiring expensive technical means.

Division of the costs of research work between the "science and technological development" sector and higher schools was in 1992 as 3 to 1 (cf. Table 4). Thus, the scale of research work in the R&D sphere was three times larger than in institutions of higher education. Between 1991 and 1992 there were considerable changes in its structure. The universities were in a more privileged situation than purely research units, and the situation in the Polish Academy of Sciences improved as compared to the ministerial institutes.

The structure of the costs of research work according to the disciplines of science (Figure 13) demonstrates that most means (over 47%) are absorbed by technical sciences. Chemistry (10%) and natural sciences (9%) are lagging behind. Since 1989, the share of technical sciences in the costs of research work has decreased quite distinctly, while that of chemical and natural sciences has increased. Due to a relative reduction of outlays into technical sciences, their structure changed in favour of all the remaining disciplines.

Unlike the structure of the costs of research work, the distribution of the equipment between the R&D sphere and universities is more uniform (Table 5).

In the years 1989–1992 the structure of equipment changed to the advantage of R&D as compared to the universities, while in science itself — to the advantage of the Polish Academy of Sciences in relation to the ministerial institutes.

The level of modernity of the equipment leaves a lot to be desired and the level of its physical depreciation is increasing. The equipment acquired in the second half of the 1980s, which at that time contributed

Table 4

Costs of research work in Poland according to the type of units at the beginning of the 1990s

Specification	Total in billion zloty current prices 1992	Structure	
		1991	1992
		percentage	
Total	7,840	100.0	100.0
of which:			
science and technological development	5,842	81.4	74.5
institutions of higher education	1,999	18.6	25.5
Science and technological development	5,842	100.0	100.0
of which:			
scientific and research units	5,834	99.0	99.9
service units	7	1.0	0.1
Scientific and research units	5,834	100.0	100.0
of which:			
research units of the Polish Academy of Sciences	1,113	14.3	19.0
department and branch research units	4,721	84.7	80.9

Source: M. Korona, *Nauka i technika w 1992 r.* (*Science and Technology in 1992*), Studia i analizy statystyczne, GUS, Warszawa 1993, p. 20.

to a considerable renewal of the resources of units, is ageing[19]. The best situation in this respect — as compared to other units — is observed in higher schools. Most of the equipment (over 50% of resources) is concentrated in the technical sciences. As compared to 1989, the equipment in the particular disciplines relatively diminished or remained at the same level (Figure 14), while the quality of the equipment deteriorated considerably.

The level of salaries in the R&D sphere and higher education is in glaring contradiction with the qualifications of the persons employed (cf.

[19] Cf. *Nauka polska w liczbach 1985–1990 (Polish Science in Figures 1985–1990)*, GUS, Warszawa 1992, p. 27.

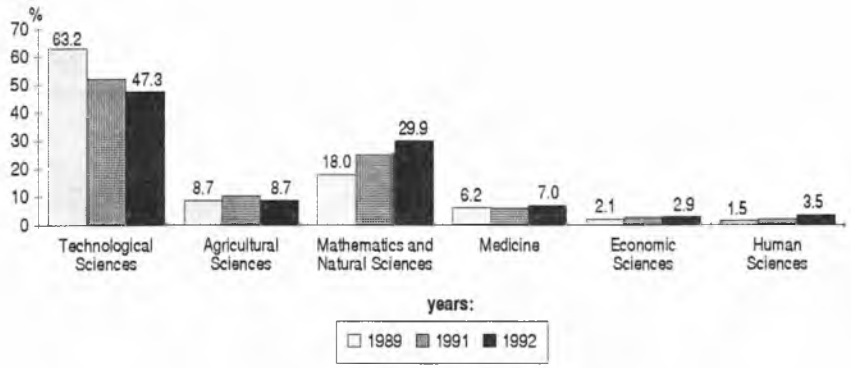


Fig. 13 Share of disciplines of science in costs of research work in Poland at the turn of the 1980s and 1990s

Figures 15 and 16), and the way of shaping incomes was not regulated upon the passage to the market economy. Although the bill passed in 1989 guaranteed the wages of the budgetary sphere at the level of 106% of the average wages in production, since 1991 the bill practically has not been put in force, since the Sejm suspended its implementation each year[20]. Instead, the state budget assigned a certain sum of money for the salary increases but its annual increase was usually lower than the rate of inflation. As a result, the average monthly net salaries in the entire budgetary sphere gradually decreased in relation to the production sectors and amounted to 92.1% in 1991, 92.0% in 1992, and 88.2% in 1993.

The salaries of the employees of the public sector paid from the budget are fairly differentiated. For example, the salaries in the R&D sphere are higher than in the universities (Table 7) and they have been growing since the beginning of the 1990s in relation to the average wage in the economy. In 1993, they exceeded the average by 21.5%. In the "education and upbringing" sector, which covers also higher education, the average salary systematically decreased as compared to the national average. In 1993, it was already 14% lower than the average. Against this backgro-

[20] I.a. by virtue of *Ustawa z dnia 30 grudnia 1992 r. o kształtowaniu środków na wynagrodzenia w państwowej sferze budżetowej w 1993 r. oraz o zmianie Ustawy o wynagrodzeniach osób zajmujących kierownicze stanowiska państwowe (The bill of 30 December, 1992, on the means for wages in the state budgetary sphere in 1993, and on the change of the Bill on wages of persons holding managerial posts in the state administration),* Dz. U. No. 1, item 1, art. 9, p. 1, and in 1994 by virtue of *Ustawa z dnia 10 grudnia 1993 r. o kształtowaniu środków na wynagrodzenia w państwowej sferze budżetowej w 1994 r. (The bill of 10 December, 1993 on the means for wages in the state budgetary sphere in 1994),* Dz. U. No. 129, item 601, art. 10, p. 1.

Table 5

The structure and level of physical depreciation of scientific-research equipment in Poland according to the type of units at the turn of the 1980s and 1990s

Specification	Structure		Level of physical depreciation[1]	
	1989	1992	1989	1992
	as a percentage			
Total	100.0	100.0	50.4	71.6
of which:				
science and technological development	45.9	49.5	48.5	80.3
institutions of higher education	54.1	50.5	53.4	63.0
Science and technological development	100.0	100.0	x	x
of which:				
scientific and research units	99.5	100.0	48.7	80.3
service units	0.5	.	.	17.7
Scientific and research units	100.0	100.0	x	x
of which:	100.0	100.0	x	x
research units of the Polish Academy of Sciences	16.7	23.9	45.9	92.4
department and branch research units	83.3	76.1	49.3	76.5

[1]The level of physical depreciation is expressed by the percentage ratio of depreciation and gross value of the scientific research equipment. This indicator has a number of shortcomings.

Source: M. Korona, *Nauka i technika w 1992 r.* (*Science and Technology in 1992*), Studia i analizy statystyczne, GUS, Warszawa 1993, p. 16.

und, the situation of the university employees was slightly better, as their average net salary was by 2.5% points higher than the national average.

The differentiation of salaries amongst the employees is evidenced, for example, by the fact that in September 1993 more than 40% of the employees received monthly gross salaries below the average in the economy which at that time amounted to 4.1 million zlotys. Several per cent of those persons approached the level of the lowest wage, amoun-

Table 6

Investment outlays per employee in "science and technological development" and in higher education in Poland in the years 1985–1992

Specification	1985	1990	1991	1992
	investment outlays in thous. zl, current prices			
SCIENCE AND TECHNOLOGICAL DEVELOPMENT	74	4,485	9,362	10,829
Scientific and research units	69	4,041	8,381	10,568
Research units of the Polish Academy of Sciences	108	5,791	9,624	14,467
Department and branch research units	65	3,781	8,175	9,926
HIGHER EDUCATION	82	3,104	6,412	6,682

Note: The years 1985 and 1990 in "science and technological development" and 1985 in higher education only full-time employees, early averages.

Source: Own calculations on the basis of table 4 and *Rocznik statystyczny inwestycji 1986* (*The Yearbook of Investment Statistics 1986*), Seria: Roczniki branżowe, vol. 33, Warszawa 1987; *Działalność inwestycyjna w 1990 r., w 1991 r., Cz. I. Nakłady inwestycyjne* (*Investment Activities in 1990, in 1991, Part I. Investment Outlays*), Materiały i opracowania statystyczne, Departament Majątku i Dcohodu Narodowego, GUS, Warszawa 1991, 1992; *Działalność inwestycyjna w 1992 r.* (*Investment activities in 1992*), Informacje i opracowania statystyczne, GUS, Warszawa 1993.

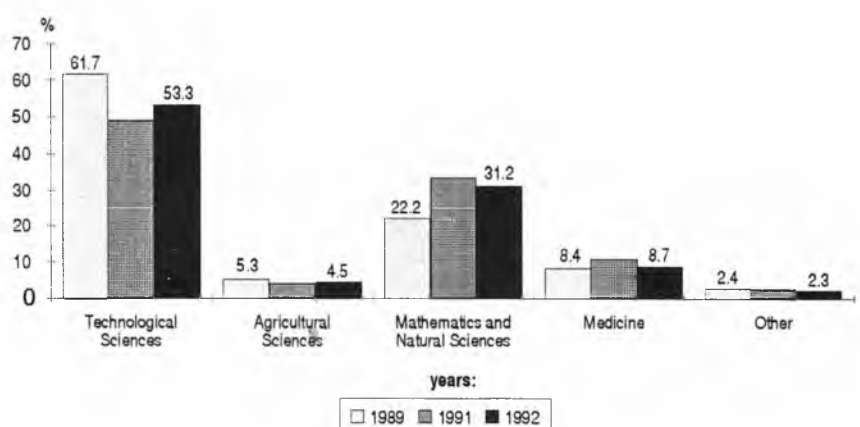


Fig. 14 Share of scientific and research equipment in the total value of equipment in Poland at the turn of the 1980s and 1990s

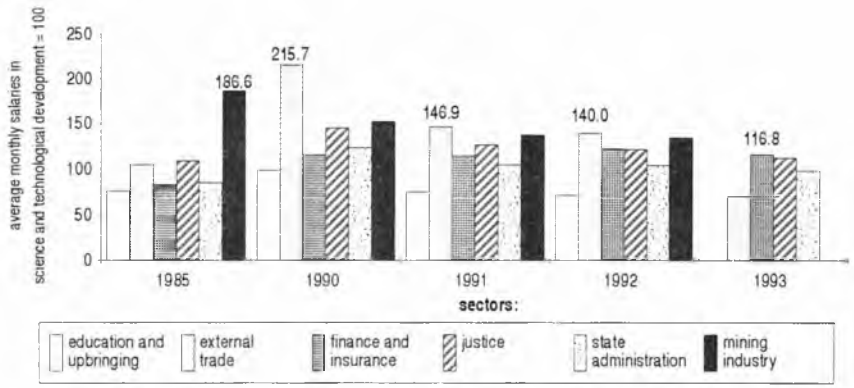


Fig. 15 The average monthly salaries in selected sectors of the national economy against a background of salaries in "science and technological development" in the years 1985–1993

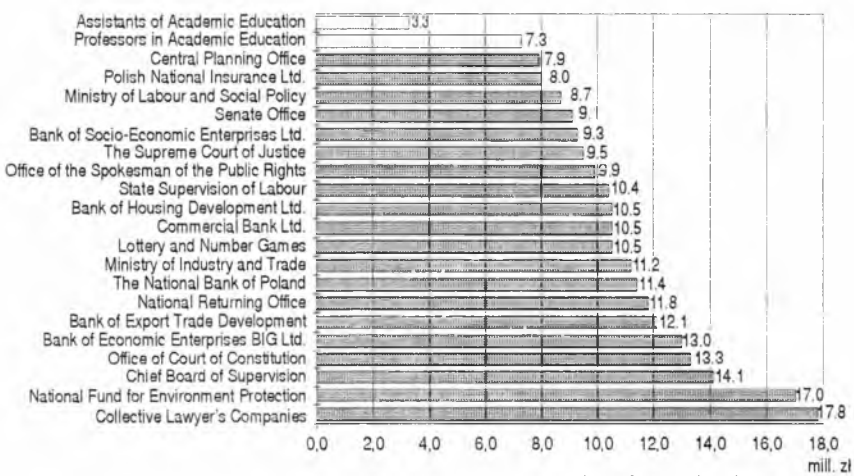


Fig. 16 The average monthly gross salary-earners in selected institutions in Poland in1993

ting to 1.75 million zlotys[21]. The impoverishment of people employed in science and institutions of higher education is one of the greatest hazards to the future of these spheres. It can be fully measured by the fall of

[21] The Instructions of the Minister of Labour and Social Policy of 27 September, 1993, changing the instructions on the lowest wages of employees, Monitor Polski No. 51, item 479.

Table 7

The average monthly gross salaries of the research staff in "science and technological development" and higher education in Poland according to post occupied in 1993

Specification	Salaries					
	science and technological development		higher education			
	in thous. zl	percentage	STD = 100		in thous. zl	percentage
Research staff total	6,559.4	100.0	100.0	69.9	4,587.8	100.0
Professors	9,961.1	151.9	100.0	73.0	7,267.0	158.4
Assistant professors	8,141.7	124.1	100.0	76.6	6,237.2	136.0
Lecturers[1]	6,403.2	97.6	100.0	71.7	4,589.5	100.0
Assistants	4,715.0	71.9	100.0	70.0	3,299.6	71.9

Note: STD — Science and technological development.

[1]ad juncts

Source: *Zatrudnienie i wynagrodzenia w gospodarce narodowej w 1993 r.* (*Employment and salaries in the national economy in 1993*), Informacje i opracowania statystyczne, GUS, Warszawa 1994 and own calculations.

Table 8

Scientific scholarships in Poland in the years 1980–1993

Specification	1980	1990	1991	1992	1993
National scholarships[1]	7,680	3,582	2,953	2,772	3,065
Higher education	5,973	3,123	2,549	2,448	2,718
Scientific and research units	1,707	459	404	324	347
of which: Polish Academy of Sciences	1,061	177	183	132	172
Foreign scholarships[2]	5,195	14,191	12,534	9,871	8,463
Higher education	4,759	13,877	10,829	7,848	6,408
Polish Academy of Sciences	436	314	1,705	2,023	2,055

[1]Doctoral scholarships.
[2]Scholarships abroad financed by national and foreign institutions.

Source: *Mały rocznik statystyczny 1994* (*Small Statistical Yearbook*), GUS, Warszawa 1994, p. 197.

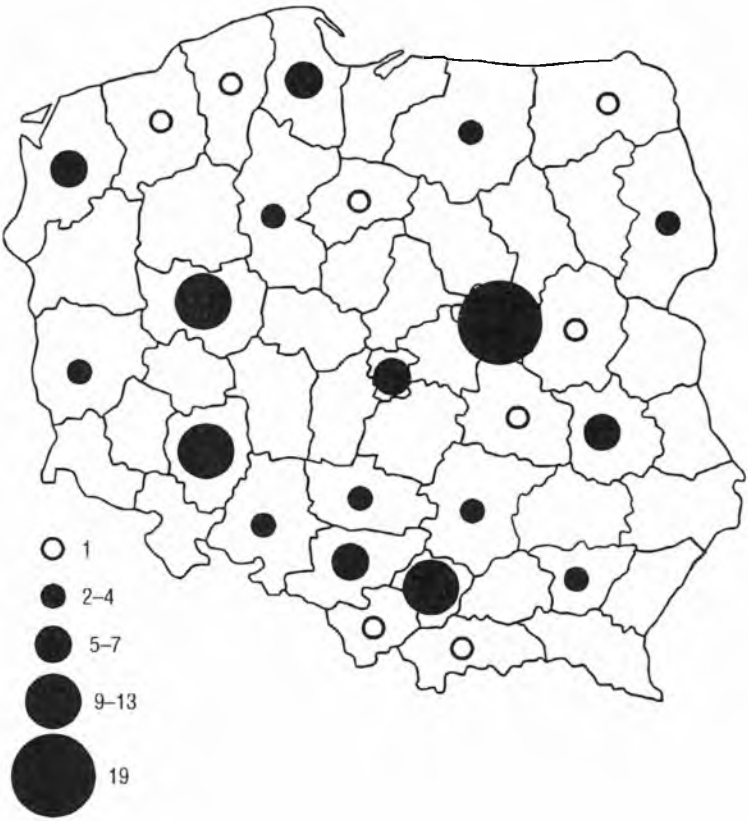


Fig. 17 Number of institutions of higher education in Poland according to voivodships in 1992

real wages. For example, in the University of Warsaw their level in 1993 amounted to 50%-60% of the 1989 level[22].

The budgets of some employees are supplemented by scientific scholarships, domestic and foreign alike (Table 8). They are granted, however, to a relatively low percentage of persons (in 1993 slightly more than 18%). The majority of them (8.5 thousand of the employees) got foreign scholarships.

It should be noted that in the 1990s this form of support for scientific and research activity has been encompassing fewer employees each year.

[22] *Sprawozdanie roczne rektora Uniwersytetu Warszawskiego... (The annual report of the rector of the University of Warsaw...),* op.cit., p. 30.

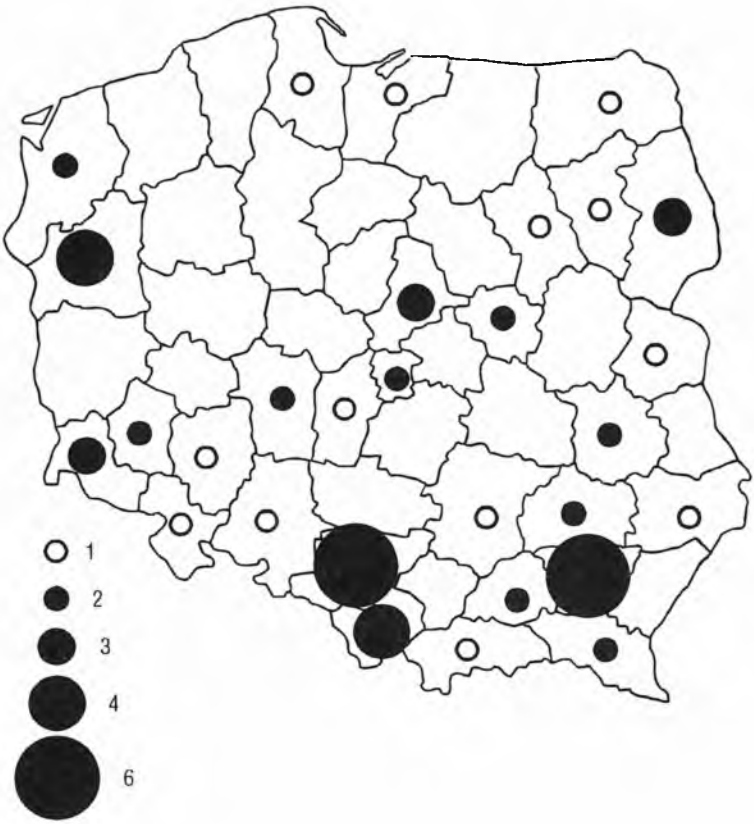


Fig. 18 Number of branches and consultation centres of higher education in Poland according to voivodships in 1992

In 1990, scholarships were granted to more than 27% of persons, in 1991 — to fewer than 24%, and in 1992 — to 20%. This is mainly due to a systematically decreasing number of foreign scholarships. Since 1990, their number has dropped by 40%. **This is the result of declining "political" interest of the Western countries in this part of Europe.**

3.5. Research and academic centres in the regional perspective

Warsaw is the largest scientific and academic centre in Poland. It is also the seat of the most important decision-making and advisory insti-

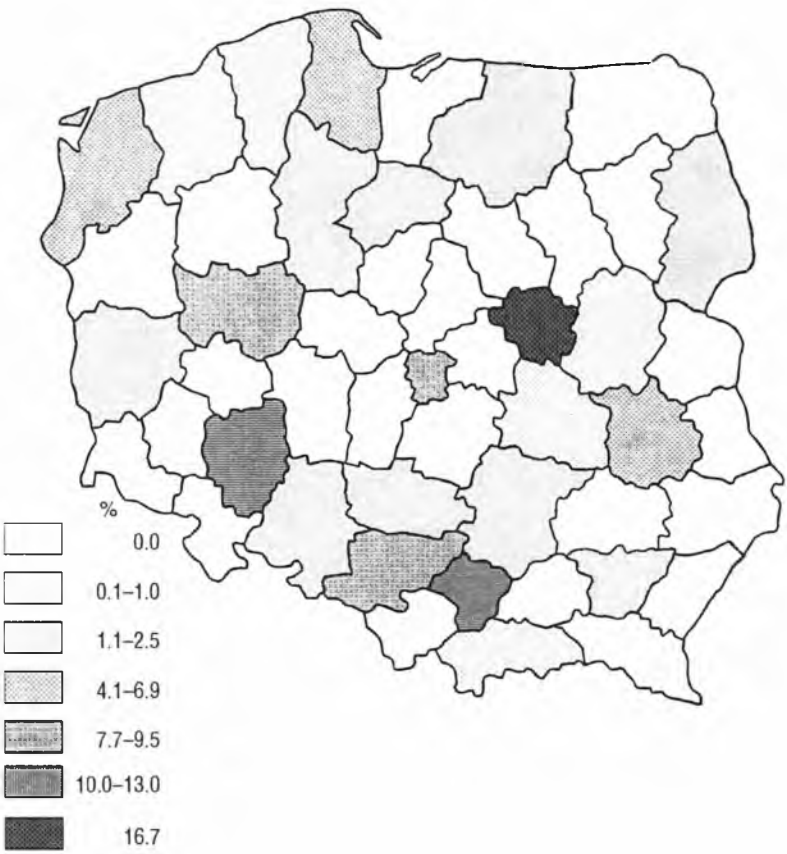


Fig. 19 Share of voivodships in the total number of academic teachers in Poland in 1992

tutions operating in the R&D sphere. Out of 127 higher schools existing in Poland in 1993, 26 operated in Warsaw. It was also the seat of half of 264 ministerial and branch research institutes as well as 53% of the institutes of the Polish Academy of Sciences.

The inhabitants of Warsaw constituted over 38% of the employees of the R&D sphere. The capital employed 60% of research staff, including 67% of professors, 63% of assistant professors and over 58% of adjoint professors and assistants. This concentration was even greater in the Polish Academy of Sciences, since the units of this institution in Warsaw employed 65% of younger research staff and more than 70% of

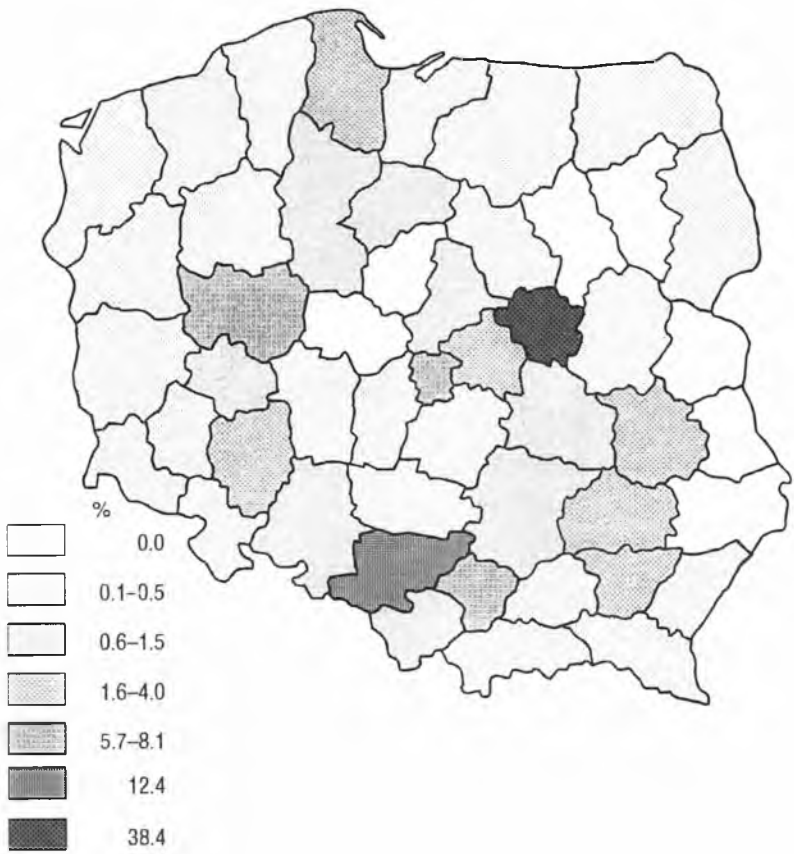


Fig. 20 Voivodships share in the total number of employees in "science and technological development" in Poland in 1992

professors. As regards higher education, Warsaw offered employment to 16% of academic teachers, including 20% of professors, 16% of adjoint professors and 15% of assistants. Out of nearly 481 thousand students more than 17% studied in the higher schools in Poland's capital.

Upper Silesia was the second largest centre of scientific and research potential, while Cracow ranked second as an academic centre. In 1992, almost 13% of the total number of the employees worked in the R&D sector in Upper Silesia. Cracow had 13 higher schools employing 13% of the total number of academic teachers and training 12% of students. Upper Silesia was also an important centre of higher education. In terms

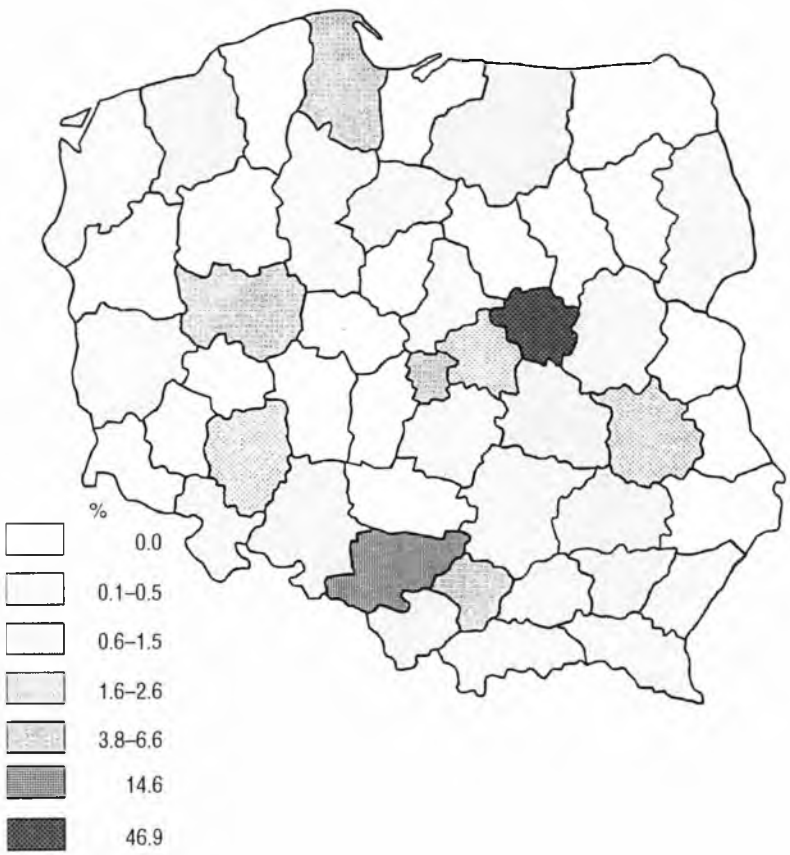


Fig. 21 Voivodships share in the total value of fixed assets in "science and technological development" in Poland in 1992

of the number of teaching staff and students, it occupied the third place after Poznań. Cracow, in turn, was the third largest centre (after Upper Silesia) in terms of scientific and research potential, concentrating more than 8% of the employees.

As regards scientific and research potential, next come Poznań, Łódź, Wrocław, Gdańsk, Lublin and Rzeszów. The number of research staff of the R&D sector ranged from 7.7% to 2.2% of the total number of employees in these towns. Wrocław and Poznań are also important university centres; they are followed by Lublin, Gdańsk, Łódź, Szczecin, Rzeszów and Białystok. The number of students in these towns ranged

from 8.6% to 2.8% of the total number of students in Poland. Wrocław is the largest centre of scientific and teaching staff; it outpaces Upper Silesia by 19% in this respect. Poznań has a slightly lesser potential; it is followed by Łódź, Lublin and Gdańsk. The above analysis shows a high degree of concentration of scientific potential in Poland. In the R&D sphere, 75% of the employees are concentrated in 10 centres, and as many as 85% are employed in higher education. The regional differentiation of the scientific-research and scientific-didactic potential as well as its characteristics are presented in Figures 17–21.

4. The Internal and External Brain Drain

In our analysis we are using the terms "external" and "internal" brain drain. The former means foreign migration, while the latter describes the phenomenon of leaving scientific jobs and passage to other sectors of the national economy. For the purpose of further analysis we assume that the phenomenon concerns all those persons who are discharged on their own demand. This, of course, is a simplification, but it might be said that with reference to the majority of persons leaving scientific jobs the assumption is correct. There are not many cases when the persons leaving the scientific institution on their own demand later find employment in other similar units.

Figure 22 shows the data on research staff discharged on their own demand and those who migrated from Poland according to the scientific research centres.

In the years 1981–1991, that is during the past 11 years, some 15% of staff left the scientific institutions and higher schools, while 10% migrated from Poland. In the years 1992–1993, about 7% of research staff were discharged on their own demand, whereas 1.5% went abroad. In the former period, the greatest outflow to other jobs was recorded in Upper Silesia, while the largest percentage of workers in relation to all the employees went abroad from Wrocław and Upper Silesia. In the latter period, Łódź had the highest percentage of discharges, while the largest number of migrants was recorded, as in the previous case, in Wrocław.

In the years 1981–1991 the greatest internal brain flight was observed in the following disciplines: economics and management, engineering and technical sciences, social sciences and law, as well as mathematics and informatics. In the last two years, the situation changed slightly: economics and management were in the first place, mathematics and informatics in second place, social sciences and law in third place and biology in fourth place.

Migrations were relatively most frequent in the first period amongst the representatives of medicine, mathematicians and informaticians as

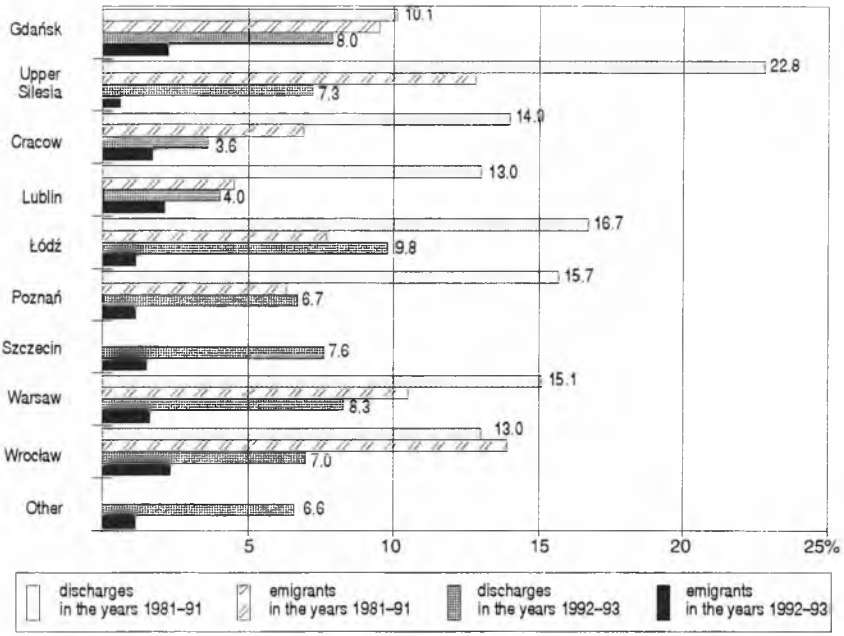


Fig. 22 Migrations and discharges of research staff on their own demand in the years 1981–1991 and 1992–1993 as a percentage of the total number of staff in scientific centres

well as physicists and chemists. In the second period, migrants included most often biologists, mathematicians and informaticians, physicists as well as chemists.

In the years 1992–1993 the greatest losses caused by the discharges and passage of employees to other institutions were recorded in agricultural academies, in the Polish Academy of Sciences and in the ministerial institutes. The greatest number of migrants came from the Polish Academy of Sciences, medical academies and technical universities.

The observation of the brain flight abroad in the years 1981–1991 shows that the phenomenon was most intensified in the first four years, that is between 1981 and 1984. Taking into account the entire period (1981–1993), the greatest number of migrants was recorded in those four years, too. This was explained by political reasons, particularly by the situation before and after the period of martial law. Between 1984 and 1991 migration was gradually shrinking, while in the last two years it has

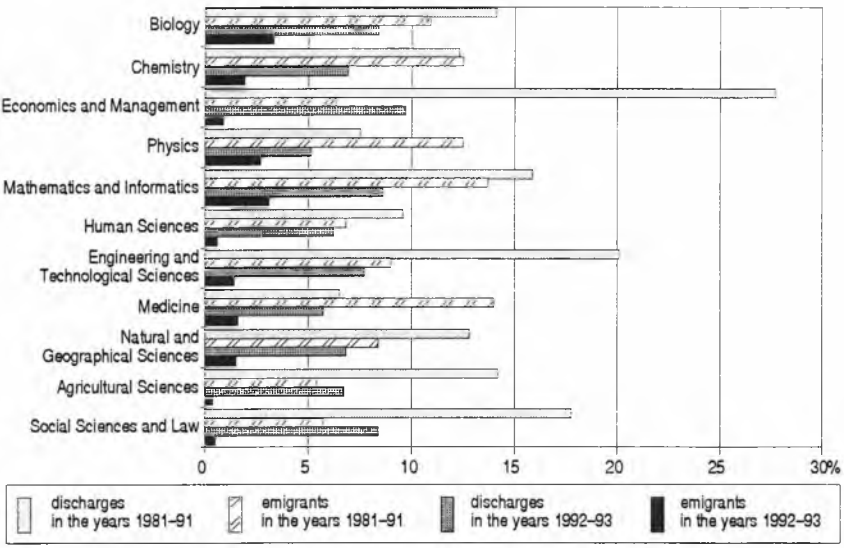


Fig. 23 Migration and discharges of research staff on own demand in the years 1981–1991 and 1992–1993 as a percentage of the total number of staff in different disciplines

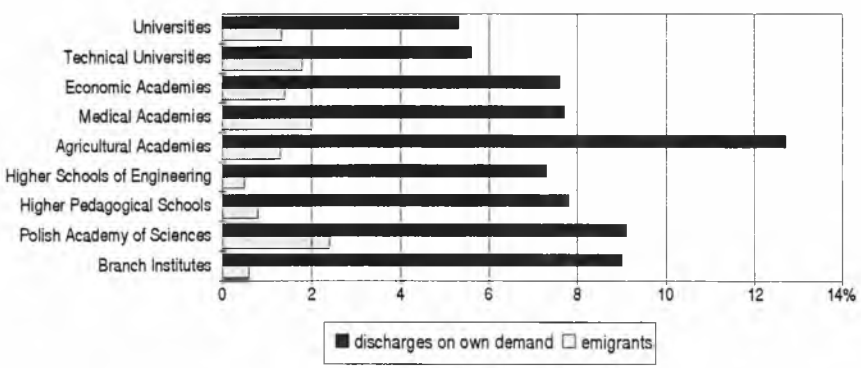


Fig. 24 Migrations and discharges of research staff on their own demand in the years 1992–1993 as a percentage of total number of staff in scientific institutions

slightly increased. For example, the average annual number of migrants in the years 1989–1991 amounted to 191, whereas in the years 1992–1993 it totalled 218 (Figure 25).

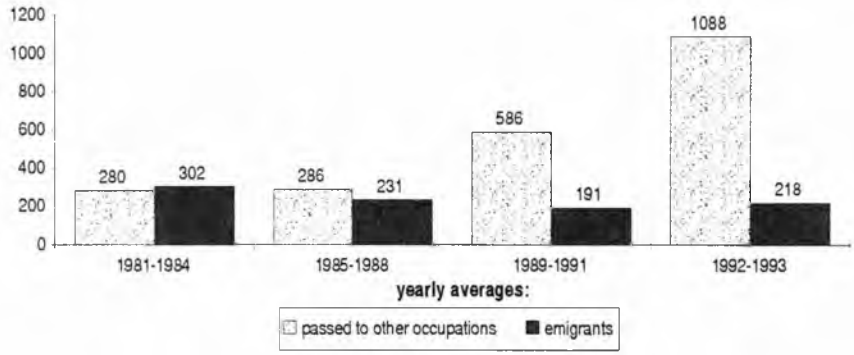


Fig. 25 The number of migrants and the scale of passage of research staff to other occupations at home in the years 1981–1993

The situation of the internal brain flight was different. It was the smallest in the early 1980s, and then the phenomenon was intensified systematically to reach in 1992–1993 the level which was almost four times larger than in the first period. The average annual outflow to other jobs at home in the early 1980s totalled 280 persons, while in the early 1990s it already amounted to 1088. In the years 1992–1993, more than 2000 people left science and higher education and took up jobs in other institutions in the home country (58% in 1992 and 42% in 1993). It is hard to say whether this well-marked fall in discharges in 1993 indicates a more stable trend or if it is purely accidental. The answer to this question will be feasible after some more studies are undertaken.

However, the study confirms the observation presented previously that the higher losses of staff in science and higher education in Poland are due to an internal rather than to an external brain flight.

Now let us take a closer look at staff mobility according to the various profiles. The relevant data is shown in Figures 26–28.

5. The Mobility of Scientific Staff in the Years 1992–1993

If one takes into account the total internal and external outflow, the greatest brain flight was observed in Łódź, Gdańsk, Warsaw and Wrocław, and the smallest in Cracow and Lublin. The relative stabilisation of scientific and teaching staff, which was previously observed in Cracow, is now quite well marked. In Cracow, the percentage of people who migrated abroad or took up other jobs at home is two times lower than, for example, in Łódź or in Warsaw. There was also a remarkable decrease in migrations and discharges in Upper Silesia.

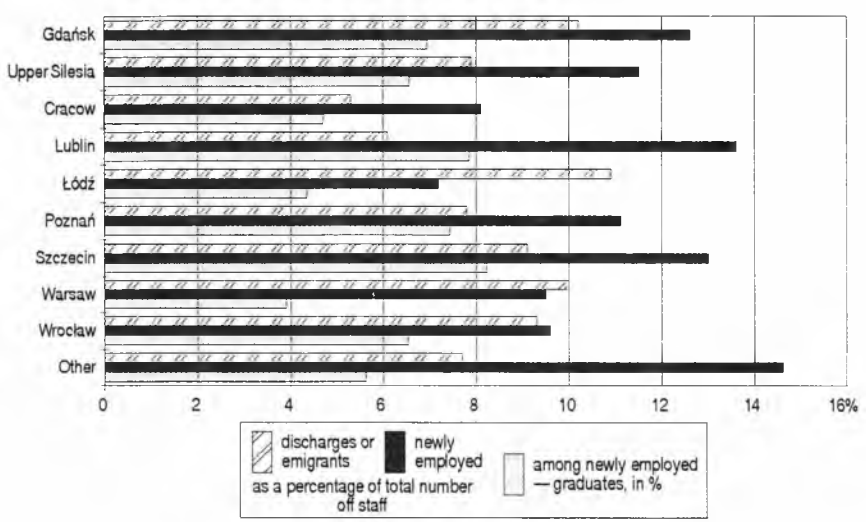


Fig. 26 Research staff who left jobs and the newly employed in the years1992–1993 according to scientific centres

In general, the brain flight does not reduce the staff potential. In the period under study, 8.5% of scientific and research staff (not including retired persons) left jobs in scientific institutions and higher schools; 10.8% were employed in their place, which means that there has been a slight increase in employment. However, the picture becomes highly differentiated in the particular centres, disciplines and institutions.

Except for Warsaw and Łódź, all the centres recorded, in the years 1992–1993, a net increase in the number of employees. The highest increase was recorded in Lublin and in provincial centres, that is beyond the nine largest centres.

It would be interesting to take a look at the data in Figure 26, which shows the share of the graduates in numbers of new employees. Among the nine largest centres, the smallest percentage of graduates was employed in Warsaw. It was lower only in small provincial centres. It seems that this phenomenon may be explained by two contradictory causes. On the Warsaw labour market there is a large number of offers from the graduates, however the competition from the institutions is so great that the offers for jobs from universities are hardly attractive. In small provincial centres, the labour market for graduates is much poorer; besides, schools in these centres want to enhance the quality of their staff potential by seeking experienced workers, mainly PhDs and adjoint professors.

The employment of foreigners in the Polish universities and research posts is not a new phenomenon, but the rapid increase in their number is a novelty. The largest number of foreigners is employed in Cracow, Poznań and Szczecin as well as in the remaining smaller centres. Łódź and Gdańsk employ the smallest number of foreigners.

Foreigners employed in Polish scientific institutions come from 49 countries; some of them may be regarded as "exotic", for example Mali, Ivory Coast, Chile, Bolivia or Thailand. Out of the total number of 291 foreigners whose nationality is known, 38% came from Western Europe, 33% from the Commonwealth of Independent Nations, 12% from the USA and Canada, 11% from various other non-European countries, and 6% from the former socialist countries.

The largest general outflow, both in the country and abroad, was observed from mathematics and informatics, biology as well as economics and management. In all the disciplines, except for physics as well as natural and geographical sciences, the losses in scientific and research staff were, though to a varying degree, compensated for the influx of new workers. The highest net increase probably took place in the human sciences as well as in biology. Talking about the net increase, we mean

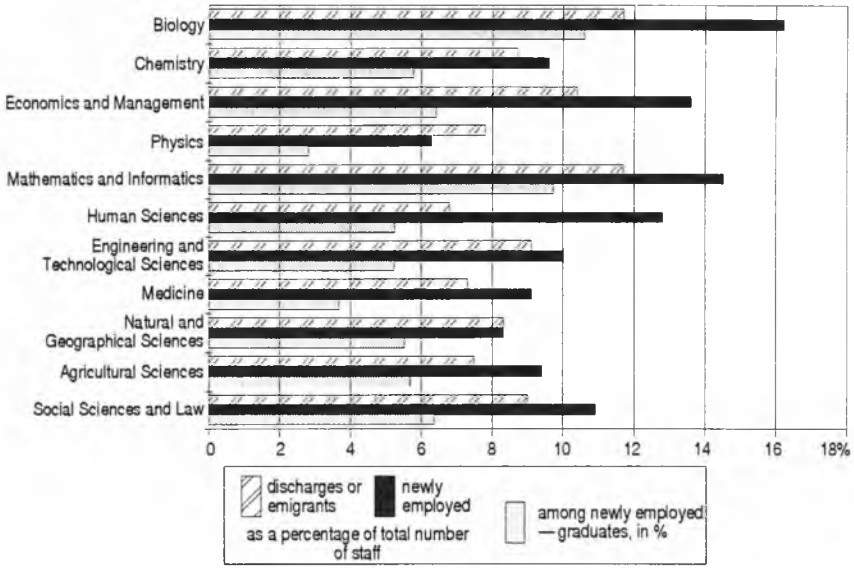


Fig. 27 Research staff who left jobs and the newly employed in the years 1992–1993 according to disciplines of science

only the balance between the number of persons discharged on their own demand and the newly employed ones (not including retiring employees). When this category is taken into consideration, the balance may be less advantageous.

The lowest percentage of graduates was employed in medicine, human sciences and in physics. The largest number of foreigners is employed in the human sciences (these are largely teachers of foreign languages) as well as in physics. The high position of physics might be due to the greatest shortages in staff in this discipline. It has now for many years faced difficulties in enrollment and it has recorded a net outflow of workers.

The largest number of persons was discharged from agricultural academies and from the Polish Academy of Sciences, whereas the largest number of employed persons was recorded in higher pedagogical schools. In the period under study, all the higher schools have a positive or zero balance (not including retired persons). The greatest net losses were noted in the research centres, that is the ministerial institutes and the Polish Academy of Sciences. The highest positive balance was recorded in the higher pedagogical schools (+8.4 percentage points), hi-

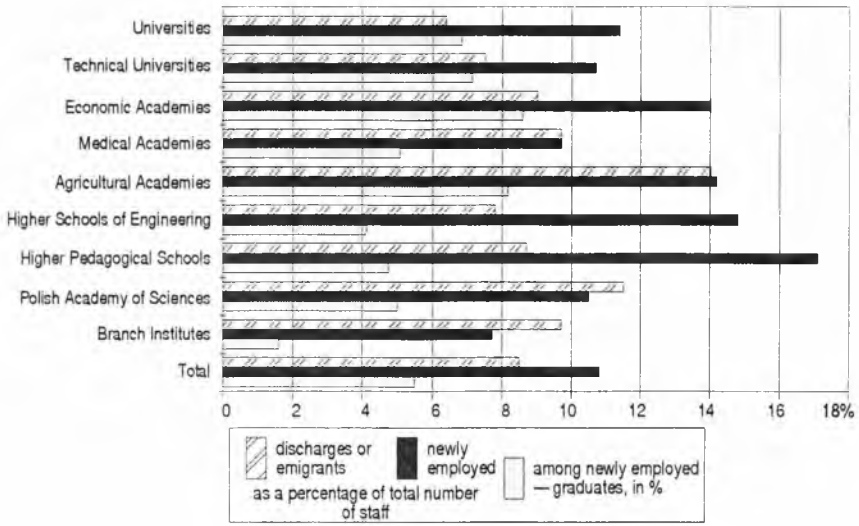


Fig. 28 Research staff who left their jobs and the newly employed in the years 1992–1993 according to the institutions

gher schools of engineering (+7), universities and economic academies (+5 each). On the other hand, the highest percentage of the graduates among the newly employed was noted in technical universities, higher economic schools and universities, while the smallest one in the ministerial institutes (30 percentage points below the average) as well as in higher schools of engineering and higher schools of education (about 23 percentage points below the average).

The largest number of foreigners (double the average) is employed in universities and higher schools of education, while the fewest foreigners work in the ministerial institutes and medical academies.

Although the fate of scientists leaving jobs in science and in the institutions of higher education is only partly known, it might be said with some certainty that about two-thirds of persons find better paid jobs in private enterprises, domestic and foreign alike, as well as start a business of their own. State administration and banks play an important role in the internal brain drain, as they employed one-fifth of former research staff. The state-owned industry is of little importance in this respect. It is worth indicating that the flow of workers among the particular universities and other scientific institutions plays an insignificant role, since only

Table 9

Employees discharged on own demand according to scientific centres and place of new employment in the years 1992–1993

Centres	State administration	Polish private firms	Foreign private firms	State industry	Scientific institutions	Own business	Banks	Other and unknown
Gdańsk	7.0	26.3	8.8	13.2	5.3	14.9	4.4	20.1
Upper Silesia	2.9	19.1	4.8	5.5	7.7	5.5	5.1	49.4
Cracow	7.3	22.0	8.3	5.5	9.2	13.8	—	33.9
Lublin	2.5	17.5	10.0	2.5	17.5	2.5	12.5	35.0
Łódź	8.4	21.7	10.8	6.9	4.9	13.4	3.9	30.0
Poznań	6.8	18.0	10.6	1.2	6.2	5.0	5.0	47.2
Szczecin	7.0	19.6	8.7	13.0	4.3	10.9	21.7	14.8
Warsaw	12.8	15.8	17.4	2.3	10.6	5.1	4.5	31.5
Wrocław	4.6	28.4	12.9	6.7	6.2	12.4	3.1	25.7
Other centres	6.6	16.7	5.7	3.1	5.7	5.7	2.0	54.5

every tenth person giving up a job finds employment again in science or higher education.

In particular centres the fate of the discharged persons varies. The percentage of people taking up jobs in state administration is the highest in Warsaw, which is evident, due to the largest number of institutions seeking employees untainted by work in state offices in the previous period. The largest number of persons took up jobs in domestic private firms in Wrocław and Gdańsk, and in foreign enterprises in Warsaw, where the number of these firms is the greatest; firms of their own were established by former research staff most often in Gdańsk, Cracow, Łódź and Wrocław.

The state administration absorbed most persons from economic academies, while the domestic private firms employed the largest number of the former staff from technical universities and economic academies. Foreign firms employed the relatively largest number of persons from agricultural and medical academies, while a business of their own was

Table 10

Employees discharged on their own demand according to the scientific disciplines and place of new employment in the years 1992–1993

Scientific disciplines	State administration	Polish private firms	Foreign private firms	State industry	Scientific institutions	Own business	Banks	Other and unknown
Biology	9.0	16.2	19.2	2.0	10.1	6.0	1.0	36.5
Chemistry	3.1	14.8	19.8	13.2	9.5	7.4	2.1	30.1
Economics & management	16.2	15.0	6.0	2.4	12.6	3.0	16.2	28.6
Physics	2.8	17.1	10.0	1.4	1.4	11.4	4.3	51.6
Mathematics & informatics	11.3	33.0	10.3	1.3	2.1	4.1	15.5	22.4
Human sciences	3.4	9.3	5.4	0.5	10.8	4.0	0.9	65.7
Engineering & technological sciences	6.9	25.9	10.1	8.5	5.4	10.4	2.8	30.0
Medical sciences	5.3	12.8	18.6	0.5	7.4	14.9	1.1	40.4
Natural & geographical sciences	15.8	19.0	4.8	—	11.1	3.2	6.3	39.8
Agricultural sciences	9.4	22.8	21.3	1.5	7.1	9.4	6.3	22.2
Social sciences & law	31.7	20.7	4.9	—	7.3	2.4	7.3	25.7

started by former employees at higher schools of engineering and of medical academies.

The state administration employed the largest number of lawyers and representatives of the social sciences. It employs about one-third of the representatives of these disciplines, who gave up jobs in scientific and didactic institutions. Polish private firms usually employed mathematicians and informaticians, as well as representatives of engineering and the technical sciences. Foreign firms, on the other hand, employed, in

the first place, representatives of the agricultural sciences, biologists, chemists and representatives of medical sciences. A business of their own was started most often by persons discharged from the medical sciences (pharmacies and private clinics, dental in particular).

Table 11

Employees discharged on their own demand according to scientific institutions and the place of new employment in the years 1992–1993

Institutions	State administration	Polish private firms	Foreign private firms	State industry	Scientific institutions	Own business	Banks	Other and unknown
Universities	5.3	18.9	11.5	2.5	6.6	6.0	6.8	42.4
Technical universities	6.7	31.3	15.4	8.2	3.9	11.3	2.3	20.9
Economic academies	14.5	30.9	9.0	—	9.0	3.6	12.7	20.3
Medical academies	6.0	13.4	21.0	0.6	6.6	14.5	0.6	37.3
Agricultural academies	8.9	21.8	25.9	2.9	2.9	10.9	6.9	19.8
Higher schools of engineering	10.0	16.8	3.3	—	6.6	13.3	3.3	46.7
Schools of higher education	2.7	9.4	1.4	—	2.7	2.0	1.4	80.4
Polish Academy of Sciences	11.2	14.4	8.8	3.0	19.4	4.2	3.9	35.1
Branch institutes	10.8	15.2	6.4	7.2	7.8	7.0	5.0	40.6
Total	176	417	244	99	171	167	94	808
% excluding "other and unknown"	12.9	30.5	17.8	7.2	12.5	12.2	6.9	—

This data confirms the emergence of the market of intellectual labour marked by great disparities in salaries which are dependent not so much on skills as on the work place. **The private sector and part of the public**

sector (state administration, employees of the state treasury companies) are in a privileged position, while the remaining part of the public sector, including education, science and health care, is being discriminated against as if offers extremely low salaries. This situation largely explains the magnitude of the internal brain flight from science and higher education.

One might certainly ask the question here whether the phenomenon under study should be called "brain flight" or — on the contrary — if it might be described as regular mobility of staff or even a rational exchange of employees. While anticipating further analyses, it might already be said now that the very outflow of employees discharged on their own demand amounts to some 4% annually, not including the retired persons. The university jobs are given up in the first place by the persons aged 30–40, well-educated scientific staff having Ph. D. or postdoctoral degree, who are usually able and enterprising and who have many years of scientific and didactic career ahead of them. The graduates employed are unable to compensate for these losses. **As a result of the internal brain flight, Polish science suffers great losses. The flight also affects the quality of lectures and classes, which are now often conducted by inexperienced staff who are recent graduates.**

6. Directions of Migration of Polish Scientists and the Professional Fate of the Emigrés

Our investigations show quite clearly that migrations of Polish scientists take place in more or less stable directions and are not subject to time fluctuations. What are the main countries of migration for Polish scientists? The United States is the unquestionable centre in this respect; it absorbed almost one-third of migrants. Time fluctuations are insignificant and oscillate in the particular periods under analysis within the range of 2%. The second place is occupied by Germany (one-fifth of migrations), though the migration to the German Federal Republic is declining. While in the period 1981–1991 more than 20% persons went to this country, in the years 1992–1993 only 14%. Third place is occupied by Canada, which absorbed every tenth migrant. In this case, too, migrations in the past two years have decreased. France practically maintains its position with a certain slight increase in recent years. All in all, every 20th scientist leaving Poland went to France.

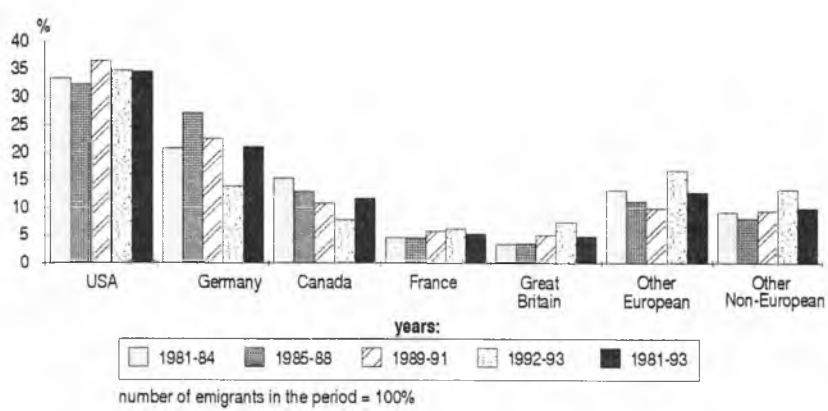


Fig. 29 Migration of research staff in the years 1981–1993 according to countries

The next fragment of the report on the study is devoted to the analysis of the further fate of the emigres. We were mainly interested in whether the migrants continue to work in science in countries of their residence. Since the questions about the further fate of migrants were addressed to the heads of the units, some vague fragments and information gaps were inevitable, but, unfortunately, we were unable to avoid this. In the previous study, we obtained some reliable information on the further fate of 990 migrants (37% of the total), of whom 614 (62%) were employed as academic and research staff, while others took up different jobs. At present we have data on the fate of 211 (49% of total) migrants, of whom 87% are still employed in scientific institutions. Despite a large number of persons whose fate is unknown, while comparing data of the previous and present study we may say with a degree of certainty that in recent years the overwhelming majority of scientists have decided to migrate only when they knew they could find a job in scientific institutions abroad. Thus, the reasons for migration have undoubtedly changed. Political and purely economic causes gave way — as one may guess — to professional motivation, that is better conditions of work and professional promotion abroad. Disappearance of political reasons is evident; on the other hand, due to the economic transformation and relative decline of the value of the US dollar and other convertible currencies, it no longer pays, for economic reasons, to take up jobs of any kind abroad.

As regards the remaining persons, whose further fate is unknown, we do not know whether they are employed in scientific institutions or not. A certain number of migrants, whose fate is unknown, may also have jobs in scientific centres, but it is more likely that they abandoned scientific jobs, since it is beyond doubt that persons continuing their career are in contact, more often, with their home institutions.

Thus we present the percentage of persons working in science as a ratio to the total of migrants, providing information about their present work places, according to the place of residence, institution and discipline in which they used to work in Poland.

In the previous period, the inhabitants of Poznań and Łódź (over one-third) continued their scientific career abroad to the largest extent, while the percentage of migrants from Upper Silesia who found employment in scientific centres abroad was very low. In recent years, most migrants who are employed in science (more than a half) have come from Warsaw, Cracow and Gdańsk, whereas the smallest percentage of persons continuing scientific careers abroad were migrants from small provincial scientific centres.

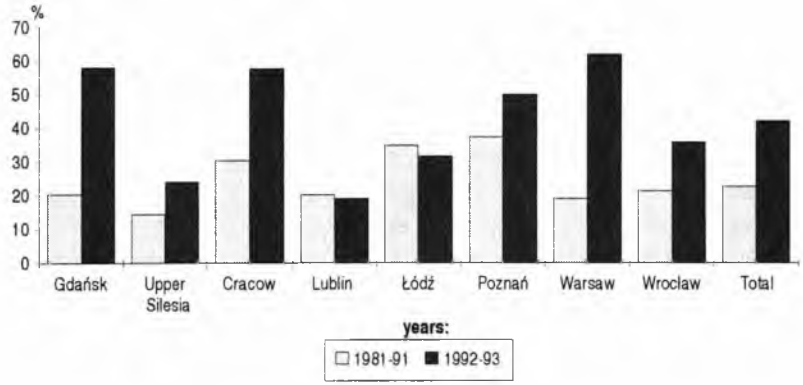


Fig. 30 Migrants in the years 1981–1991 and 1992–1993 who continued to work in scence according to scientific centres

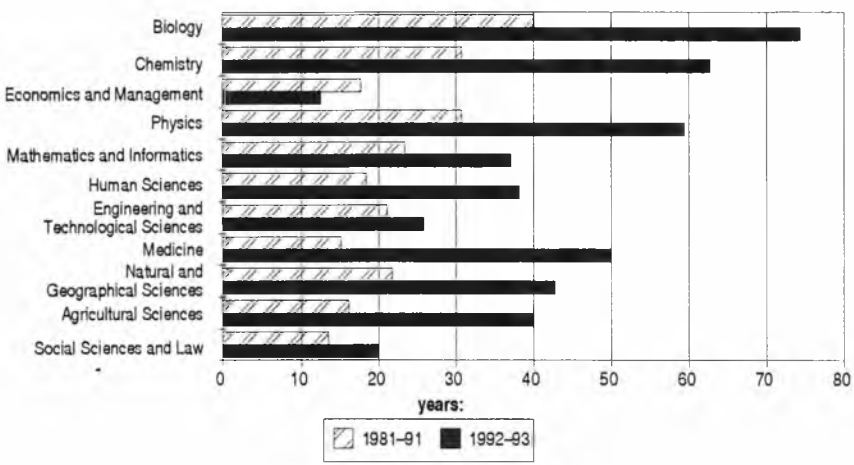


Fig. 31 Migrants in the years 1981–1991 and 1992–1993 who continued to work in science according to disciplines
(total number of migrants in the discipline = 100)

The results in Figure 31 show that biologists have the greatest opportunity for finding employment in science abroad, since almost three--fourths of migrants continue to work as scientists. Chemists, physicists and representatives of the medical sciences have smaller (but higher than the average) opportunities relative to the entire group of scientists migrating from Poland. Representatives of the social sciences and

lawyers, economists as well as representatives of technical sciences are quite rarely employed in science abroad. As we have already mentioned before, migrants from the period 1992–1993 continue to work in science much more frequently than migrants from the previous period, though the opportunities for the particular disciplines increased unevenly. The greatest increase in opportunities noted for the representatives of the medical science as well as for chemists and physicists.

However, if we consider this problem through the prism of scientific institutions, the relatively largest number of migrants who find employment in science come from the medical academies, universities and technical universities, whereas in the previous period — from universities, agricultural schools, technical universities and medical schools. At first sight, it seems evident that if the representatives of a given school of higher learning or scientific discipline find jobs in science in the West more often than representatives of other disciplines, their qualifications are more consistent with the requirements of the foreign scientific institutions. This hypothesis seems more probable in view of the clear-cut segregation of Polish scientific institutions from the point of view of their capacity of preparing their employees for scientific activity abroad.

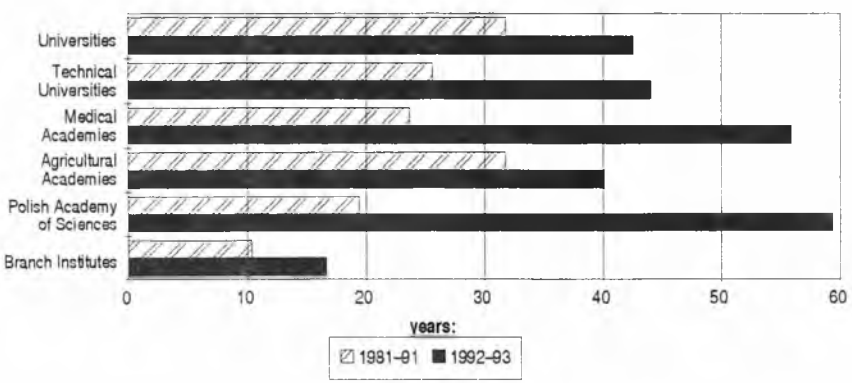


Fig. 32 Migrants in the years 1981–1991 and 1992–1993 who continued to work in science according to scientific institutions
(total number of migrants in the institutions = 100)

The results of the study show that the workers of ministerial (branch) institutes make up a lesser percentage in the brain flight. This may indicate that the world market of scientific labour weakly absorbs specialists

in applied research and implementation, since such skills are less universal and they are related to a concrete product in a concrete factory. Most of people who continue to work in science are the former employees of the Polish Academy of Sciences, as well as of the medical academies and universities. The former workers of the higher economic, education and engineering schools are not employed in science at all, and persons working formerly in ministerial institutes — only to a small extent.

7. Financing the Research Units

To conclude this part of the analysis it is worth presenting the ways of financing scientific units because they have a direct impact on the external and internal brain flight. The relationship between the financial resources of the unit and stabilisation of its staff is very likely. Greater financial means of the units allow them to purchase the equipment, which results in a better workshop; besides, additional (non-budgetary) funds, permit increases — in some cases even significant ones — in the salaries of the employees.

Table 12

Sources of financing scientific units in 1993, in percentage terms

Percentage of total means	Financing of units	Grants of the KBN	Other ministries	Enterprises	Foreign programmes
0	14.7	25.6	67.2	59.1	70.9
1–5	0.8	4.8	5.4	4.4	7.5
6–20	6,1	14.6	7.2	9.8	4.4
21–40	12.3	14.5	2.9	5.0	2.0
41–60	15.0	10.2	1.6	3.9	1.2
61–80	12.4	7.0	1.1	2.4	0.0
81–100	24.8	9.4	0.7	1.5	0.1
Missing data	13.9	13.9	13.9	13.9	13.9

Only every seventh unit is not financed by any institution; these are probably those scientific institutions which were classified by the Committee for Scientific Research under category "D". At the same time,

however, the financing of one-fourth of the institutions constitutes 80 to 100% of means at its disposal. In 1993, one-fourth of the units did not receive any "grant" so that their level is most probably much lower than the average. However, for every sixth unit this source of financing makes up some 60% of available means. One-third of the centres are financed directly by the ministries (not by the KBN), but these resources are in most cases insignificant. Only every fiftieth unit receives over 60% of its resources from the ministries. The contribution of enterprises to the financing of science is greater. This source provides the resources for almost half of the units, and in the case of every eighth institution these resources constitute more than 20% of its total resources. Remarkably, every third Polish scientific institution takes part in the international research programmes and makes use of foreign resources. These resources are not great, but in the case of 8% institutions they even range from 6% to 60% of the total means available, while in every thirtieth unit foreign "grants" make up 20% to 60% of their budgets. Obviously, in these cases these sums are already significant.

8. Response of Employees and Academic and Research Institutions to the System of Financing Research

In the course of further analysis we present the effect of the way of financing scientific research on migration of research staff and their passage to other jobs at home. We shall also discuss the strategies of scientific institutions which are the outcome of the current system of financing research.

8.1. Employment policy of academic and research institutions resulting from the system of financing science

The need for discussion of these problems seems evident in the light of the information on the "ageing of Polish science" and the absence of exchange of staff between the scientific units. It is clear that the above-mentioned lack of inflow of new employees to the scientific institutions coincides with the lack of inflow of new ideas and research methods and leads to decreasing creativity of scientific teams.

Science policy, particularly its most important fragment consisting of the financing of institutions and scientific research, should thus counteract the threat of the disappearance of creativity. It seems that at present it would be proper to allocate money in such a way as to allow the institutions having sizeable potential of qualifications and creativity to employ new research workers more often than in the remaining units. This demand may be brought into force more effectively if there is a better assessment by the ministry financing science of the potential of research institutes and a better evaluation of the subject matter of applications for grants. Our study has revealed that implementation of these two demands meets with strong objections from the scientists.

In the course of further analysis attempts will be made to find out whether the way of financing scientific institutions and scientific research is propitious to employment of new workers, with special reference to university graduates.

In order to make relevant calculations we shall make use of the correlation analysis conducted on the following variables:

- "employed" — number of persons employed in the given institution in 1993;
- "emigrants" — number of employees of the given institution who left in the years 1992–1993;
- "discharged" — number of employees of the given unit who passed to other occupations in the years 1992–1993;
- "newcomers" — newly employed research staff in the years 1992–1993 in percent of total employment in the given scientific unit in 1993;
- "graduates" — total number of graduates employed in the given unit in the years 1992–1993, in percent of total employment in the given unit in 1993;
- "financing of units" — percentage share of the financing of units in the financing of scientific research carried out by the given unit in 1993;
- "grants" — percentage share of the KBN grants in the financing of research;
- "industry" — percentage share of other ministries as well as of industrial enterprises in the financing of research;
- "foreign" — percentage share of foreign funds in the financing of research;
- "scientific disciplines": 11 binary variables: engineering, medical, humanities, social sciences and law, biology, physics, natural and geographical sciences, chemistry, agricultural sciences, economics and management, informatics and mathematics.
- "scientific institutions": 9 binary variables: universities, technical universities, economic academies, medical academies, agricultural academies, higher schools of engineering, higher schools of education, higher naval schools, Polish Academy of Sciences.

In order to illustrate the dependencies between variables we shall use the Pearson correlation coefficients. We shall start our considerations with the discussion of the relationship between the way of financing scientific research and the employment-related policy pursued by the scientific institutions under investigation.

The coefficients included in the table 13 are, unfortunately, statistically insignificant. However, this will not stop us from attempting an

Table 13

The Pearson correlation coefficients measuring dependencies between the means of financing research and employment policy of scientific units

Variables	"newcomers"	"graduates"
"financing of units"	.0390	.0047
"grants"	.0302	−.0062
"industry"	.0329	−.0061
"foreign"	−.0271	−.0292

assessment of the tendency they reflect. In this case, we shall not analyze the magnitude of coefficients but a positive or negative character of the dependencies between variables.

Thus, the table shows a positive impact of the financing of units on the increase of employment in scientific units of both kinds of groups of employees. This indicates that the greater the share of the financing of units in the financing of research, the greater is the probability of growth of employment in a given unit and the employment of graduates. Although the increase of the share of grants and other orders is conducive to the growth of employment in the unit, it is not propitious for the employment of graduates. The magnitude of foreign funds has no effect at all on the willingness to increase employment in the scientific units under study.

The results obtained allow us to state that the present system of financing scientific research makes the scientific units create two kinds of strategy in employment. The first kind of strategy can be observed in the scientific units with a relatively high share of the financing of the unit. It may be expected that this state of affairs creates in the units the feeling of long-term stability in the domain of the inflow of resources. This creates a favourable climate and readiness to employ university graduates and to assign some of the means for their training and adjustment to the work in a given unit.

The second kind of strategy can be found in those units in which KBN grants, demand orders from other ministries or enterprises as well as foreign funds have a greater share in the financing of research activity.

It may be supposed that the sporadic character of this type of financing creates the conviction of the lack of long-term stabilisation or even uncertainty as regards the future financial situation. Thus, the strategy of these units is largely focused on the acquisition of financial means. Hence these units seek, on the labour market, qualified researchers able to carry out current research, but they avoid employing graduates, who must be trained first, which takes a long time. This is the case of a peculiar "supercommercialisation". These units have sources of financing thus offering higher salaries and attracting qualified researchers. This is propitious for the maintenance of a high level of the topics by ensuring the influx of new people and ideas to a given unit, but from the point of view of science as a whole the effect is negative because there is no reproduction of the staff.

Let us come back now to the previously presented analysis regarding the stimulation, by way of science policy, of the exchange of ideas and research methods among the scientific teams.

Our study shows that in those institutions where the KBN funds are allocated, the inflow of employees is growing. But it may be purely accidental since correlation coefficients were statistically insignificant. This indicates that the current policy of financing scientific research has a poor or no effect at all on the behaviour of scientific units on the labour market and on their employment policy. It is specially significant that those scientific units which receive great subsidies from the KBN tend to limit the employment of graduates. **In other words, scientific units which are regarded by the KBN as the best ones, that is they obtain the largest number of grants, are reluctant to pursue development, which must be based on employing, training and upgrading scientific staff.**

This leads to the conclusion that in order to encourage scientific units to employ and upgrade graduates, the extent of the financing of units should be radically changed to encompass many more scientific units.

8.2. The system of financing research and the internal and external brain drain

Low salaries of research staff and lack of financial prospects for the future are important reasons for migration and vacancies in science as well as passage to other occupations at home. It may therefore be expected that extra orders in the shape of grants or demand orders of enterprises for research considerably improve the financial situation of the employ-

ees and reduce the pressure to migrate abroad or leave scientific jobs and pass to other occupations in the home country. So let us take a look at Table 15 which confirms these expectations.

Table 14

The relationship between financing research and leaving scientific jobs and migration of research staff, measured by the Pearson correlation coefficients

Variables	"emigrants"	"discharged on own demand"
"financing of units"	−.0243	−.0827*
"grants"	−.0209	−.0835*
"industry"	−.0216	−.0739*
"foreign"	−.0214	−.0783*

*significant coefficients

The table 14 shows that if the unit uses various forms of raising salaries of its workers, their readiness to migrate abroad is declining. Since, however, correlation coefficients are insignificant, it may be assumed that grants and other orders have a little effect upon decisions of research staff not to leave the country, since extra earnings due to grants and other orders are considerably lower than salaries offered abroad. That is why the social value of these methods of financing as incentives is small or even negligible in respect of decisions regarding migration.

The situation is different as regards the conditioning of the decision to pass to other occupations at home. In this case the value of all coefficients is statistically significant. This indicates that the social value of the various forms of financing research as incentives is considerably higher and the possibility to obtain extra earnings has a positive impact on the continuation of work in science. Let us notice that the correlation coefficient measuring the impact of orders from the institutions other than the KBN on decisions regarding the passage to other occupations at home is lower than the two remaining ones. Thus it should be concluded that apart from financial incentives psychological incentives come into play, too. In order to verify this hypothesis, we have analyzed the regression using the variables included in the table and it appeared that in the case

of the orders of enterprises, the direction of the dependencies between this variable and discharges was reversed. Unfortunately, the coefficients turned to be statistically insignificant and that is why they have not been quoted.

The results of the interviews show that the orders of enterprises are usually practical and of little value as an intellectual stimulation. Although this work is well paid, the employees are not always willing to undertake it and prefer rather strictly scientific research offering better prospects for intellectual satisfaction. That is why the orders of enterprises received by a given unit are much less effective in counteracting migration from science than stable financing of units and grants from the KBN. This is most probably due to the fact that in the milieu of the research staff the motivation for of job satisfaction dominates over financial considerations. This indicates that at present and in the future alike, the research staff satisfaction in their work will be conditioned by participation in fundamental research rather or in other works allowing for a creative approach to the subject of research. Applied research or consulting will be rather treated as a source of extra income or even as a must. This reveals important practical hints for the policy of financing research.

If one of the purposes of this policy is to restrain brain flight from science, the means for financing units and grants must be radically increased. The orders of enterprises will not ensure such effects, while foreign orders will never be large enough to encompass a considerable number of scientific units. Besides, the work conducted in this manner is propitious for the implementation of foreign projects and does not have to be applied for the improvement of the Polish economy.

8.3. The financing of research according to institutions and scientific disciplines versus migration and strategies on employment policy

The correlation analyses conducted have shown that only three scientific disciplines significantly differ from the remaining ones in respect of migration trends. These are: mathematics, physics and informatics with mathematics.

Amongst physicists and informaticians the number of migrants is significantly higher than in the case of the workers of other scientific disciplines. However, the economists show a statistically significant tendency

Table 15

Relationship between magnitude of migration of research staff and the financing of research according to scientific disciplines. The Pearson correlation coefficients

Variables	"physics"	"informatics"	"economics"
"emigrants"	.0950*	.1099*	−.0853*
"financing of units"	−.0562	.0791*	.0696
"grants"	−.0608	.0886*	.0687

*significant coefficients

to avoid migration and stay in the home country. At the same time, the value of means for research received from the budget is considerably higher in informatics than in the remaining scientific disciplines. Thus, this confirms the previously described processes showing that the financing of units and grants are at such a low level that they cannot compete with salaries abroad and they do not significantly counteract migration of science staff.

The intensification of the work and research means in informatics is undoubtedly in the interest of Poland's economic development. Unfortunately, the low salaries cause that these means lead to the increase of the level of qualifications of research staff, while the benefits from this type of investment are transferred abroad together with the migrants. Thus what we observe is the transfer of Poland's national income to more affluent countries.

The higher schools of education and higher economic schools receive significantly more resources for scientific research than the remaining scientific institutions, whereas the higher agricultural schools receive significantly fewer resources. Thus two kinds of strategies can be observed here: defensive and offensive. The former is carried out in agricultural universities. The relatively great difference between correlation coefficients measuring the financing of research and employment of new workers seems to indicate that in the higher agricultural schools the policy of defence of the state of employment is carried on at the expense of the magnitude of salaries. In the case of two "financially privileged" kinds

Table 16

Dependencies between the ways of financing research and the employment policy of scientific institutions. The Pearson correlation coefficients

Variables	"economic academies"	"higher pedagogical schools"	"agricultural academies"
"financing of units"	.1264*	.1241*	−.0884*
"grants"	.1236*	.1149*	−.0835*
"newcomers"	−.0550	.1353	−.0609

*significant coefficients

of colleges we can observe a development strategy, which is, however, carried out quite differently.

In higher schools of education there is a quite clear transfer of research funds to the new jobs rather than to extra earnings, while in the economic and business schools the situation is reversed and salaries are being increased at the expense of new jobs. This strategy leads to such an increase in extra pay that it is an effective barrier to migration of the economists.

Schools of education are oriented towards the increase of the number of employees using the research funds, which is certainly accompanied by the increase of the number of students, which in turn will permit a stabilisation of salaries and staff in the future to be based on the realisation of teaching tasks.

Economic universities, on the other hand, seem to implement a unique strategy aimed at the improvement of the market position of the economists to be based on limitation of access of new workers and graduates. This leads to the decline of competition within this professional group and at the same time exerts a certain influence on the increase of prices and services due to a relatively small number of people offering these services.

All the remaining universities and institutes of the Polish Academy of Sciences are not significantly distinguished in the domain of response to the system of financing scientific research.

The current system of financing scientific research actually does not counteract migration of research staff, since extra earnings that can be obtained are considerably lower than salaries abroad. However, the value of the financing of units and grants significantly counteract the passage of research staff to other occupations at home. The orders of enterprises, even though they have a positive effect on the magnitude of salaries, do not offer intellectual satisfaction and do not counteract the brain flight.

The analysis of migration according to scientific disciplines shows that **the way of financing is usually consistent with the tendencies of development of the world economy and science, but it causes that the benefits from this investment are exported abroad together with the migrants.**

9. The Brain Drain and Its Effects as Seen by the Managers of Polish Science

This chapter includes an analysis of the interviews with managerial staff of Polish scientific institutions. The interviews went far beyond the subject matter of the external and internal brain flight. However, they appeared to be so interesting that it is worthwhile presenting them as fully as possible.

The problems discussed are presented under 8 points. All the opinions, sometimes contradictory, have been presented. They undoubtedly show the views of the Polish scientific milieu. Some opinions are repeated, but they are quoted as they present variants of similar views.

9.1. Foreign migrations

Permanent migrations have ceased to be a major problem. Firstly, scientists do not take up jobs equivalent to those left at home. Formerly, when the currency rate was different, it paid to leave and take up any kind of job. For example, the adjoint professor was employed as a laboratory assistant. Since he formally worked in science, he did not lose much status, but he gained a great deal in financial terms. Today, however, scientists who migrate from Poland for good because they get equivalent posts abroad, constitute a small percentage in the experimental sciences.

The attractiveness of foreign migrations considerably decreased; sometimes, there are even no candidates for foreign scholarships. Formerly, when someone got a scholarship in the USA — let us say 15–20 thousand dollars — and if he saved part of this amount of money, in Poland it was a lot of money. At present, it is not possible to get a foreign scholarship and take paid sabbatical leave simultaneously in order to support a family. Thus, one must consider what part of the scholarship should be assigned to support the family either at home or abroad. People are no longer inclined to sacrifice themselves.

Ease of travels and contacts are of some importance, too. It is quite easy now to obtain means for travel. For example, there are many European programmes which facilitate this (TEMPUS, COPERNICUS). Thus, foreign contacts do not need to entail permanent migration.

Thus, the external brain drain has shrunk considerably. The possibilities of finding employment in foreign institutions are incomparably worse than they used to be. This is due to the shrinking market for research labour as well as to political reasons. In the past, the Poles "escaping" abroad received assistance, but there is no need to do it now.

The United States was the main market on which employees of many experimental institutes appeared. In one of the Warsaw medical institutes, 36 members have migrated to the USA since 1981; most of them left in the early 1980s, but this phenomenon has continued. However, this "drain" in the domain of medical and bio-medical sciences concerns all countries. For example, 30% of the British who go the United States stay there. If we compare these data with our statistics, the situation is probably similar and it should be viewed as a regular transfer of employees.

However, the brain drain is still quite clear in some experimental faculties. Most of the employees of good institutes go to take up foreign training and stay abroad as they have much better working conditions there since it is not only money that matters. However, this drain was hampered in such disciplines as law, economics, and management, since a competitive market emerged in these fields.

In some disciplines, e.g. biology, migrations to foreign countries and the taking up of jobs in science are the best indicators of the quality of the institute. The more persons migrated to the West, the better was the education of scientists in the given institute. A proper assessment of the institutes was the opposite of the officially binding evaluation. If a unit was assessed as "excellent", and none of its employees went to the West, the authorities should have considered its liquidation.

In several universities now there are sizeable groups of professors who have maintained long-lasting contacts with foreign universities and stayed abroad for a long time, usually due to better equipment. They do not declare they want to reside abroad permanently, but stress that if they are to work as scientists, they must do it in well-equipped laboratories. They come back to Poland for some months and then they leave again. This is quite a numerous group of physicists and a few biologists.

The situation in Poland is gradually changing; research staff leave, let us say for one, two or three years and then they come back, sometimes

to another institute, although these returns are often difficult. I know of some people who went abroad and worked in excellent scientific units and after they came back to Poland, they could not find a scientific job.

Grants allocated by the KBN — also to young research staff — cause that in some disciplines, e.g. in biology, the situation has improved. People go abroad but they come back because they have their workshop here. Many universities managed to create such conditions for work as to make travel abroad supplementary rather than the purpose in itself.

Scientific exchanges between Polish and foreign universities is now becoming two-directional, since many persons working in the United States have begun to consider the possibility of returning to Poland. One of the outstanding scientists employed in Harvard Medical School, which is a medical college of world renown, made a real career there, and he is now writing a postdoctoral dissertation in Poland. If someone makes up his mind to travel, which is expensive, it may be expected that there are some considerations regarding the future behind his decision.

Many respondents gave examples of scientists who returned to Poland or are considering this; meanwhile, they stay in touch with the scientific units in Poland.

9.2. Science policy of the state

The present-day policy of the state authorities leads to the wasting of outstanding individuals, which is particularly dangerous now that they are free to leave the country. Within a couple of years, along with a closer integration of Poland with Western Europe, the situation will deteriorate further. Most of the outstanding Polish scientists, who will not have to fear competition, when facing the choice of having incomes 20–40 times higher than in Poland, will choose jobs in foreign universities.

In June 1994 the rectors of more than 30 Polish higher schools having full powers to confer scientific degrees, published a report on the state of Polish science. It includes a forecast of development potential of Polish science and the ensuing consequences for Poland's place in Europe, or — more precisely — in the international division of labour. **Catastrophic effects of the current lack of care for science in Poland will manifest themselves in 5–10 years. It may be expected that this will be the time of the ultimate division of intellectual labour. If the situation does not change, Poland will lose its intellectual contacts with the world. We will cease to make any contribution to Europe's development or even take**

part in it. Thus, Poland's role will confine itself to the provision of a poorly qualified labour force.

There is a tremendous menace to science; over the past four years, when the budgetary expenditure was adjusted, outlays on culture and education were cut down in the first place, but science was the one to have lost most. The authorities assume that this will do no harm; all that can happen is the collapse of some institutes and passage of a few of scientists to other occupations. This is the lack of consistency, as it might be better to liquidate science completely because some rich countries, including Kuwait or Sudi Arabia, have no science. All the same, the ruling elites are conscious or subconscious of the fact that one can hardly imagine a civilised state without science. Therefore, they try to keep up appearances, just for the sake of international public opinion. The elites, however, do not understand that there can be no development of the country without scientific development.

A scientific career is unrewarding for several reasons. This is not only due to low salaries and small outlays on research. Science in Poland has lost its social prestige. It is disregarded by the society, the political elites, and by the mass media. It seems that many journalists do not know exactly what science is. They often mix the two terms and when they talk about science, they mean education. If they enumerate publicly some sectors of the so-called "budgetary sphere", they usually mention health care, culture and education. Science has an immense culture-generating potential and it exerts a great influence on education, but it is something different.

Science as such has hardly been the object of discussion in recent years. The parliament has had much debate on various issues over the past four years, but no debate was devoted to science and scientific policy of the state. And yet we know that the development of modern civilisation is carried on mainly due to science. In Poland, there is still a widespread belief that it would suffice to buy a licence in order to develop the economy and create technological progress. It may certainly be said that it is a partial solution for countries with such a backward industry as Poland is, but on condition that licences will be good and appropriately used or even modernised.

Apart from an ad hoc policy — for one or two years — the state must have its future vision, regardless of the strategy of winning the nearest elections since there are matters which will be important for the state and society no matter who will be in power after the successive elections.

Adaptation of foreign industrial achievements at home, such as, for instance, the starting of the Fiat car factory, is solely a transfer of alien solutions. However, the design offices, which develop motor-car technology, are not seated at Tychy or Bielsko-Biała but in Turin. Only the assembly workshops are situated in Poland. The factories of washing powders located in Poland are only places where imported ingredients are mixed, and we must remember that in some domains the Polish industry did have modern laboratories.

The current policy of the state leads to elimination of creative potential of Polish science. We simply confine ourselves to "black labour". The result will be that Poland will enter Europe as a "housemaid" and not as a more or less equal partner. So far, there has been no far-reaching strategy of scientific development and its utilisation for the civilisational development of Poland, or the strategy of using the country's intellectual potential. There can be no excuse that there are many other problems. They are only apparently more important than the development of science since they are the ones to decide what Poland will be like within 20 years to come.

The country which assigns barely 0.5% of its national income for science, certainly has no scientific policy. Besides, since the establishment of the Committee for Scientific Research we have probably had the most centralised system of management of science in the world. The KBN takes decisions regarding all means, whereas the system of individual grants loosens the ties between the managerial staff of the institutes and the scientific councils on the one hand and research staff on the other hand. This is also the case in Western countries, but grants have a much smaller share in the sources of financing there.

9.3. The financing of science

The bulk of financial means of the research institutes of the Polish Academy of Sciences and ministerial institutes comes from the KBN. These are the funds for the so-called statutory activity allocated to the units without any consultation with their founding organs. Next come grants (18%). Other sources of financing are of minor importance. Technical sciences practically do not use foreign sources, while the orders of enterprises, which are fraught with difficulties and often lack money for wages, ended up with the passage to a market economy.

Concentration of means in one institution, as the KBN is, is not normal. Let us compare the situation in other countries in which means for science also come from the state budget, e.g. in America, England, France or Germany. The budget assigns part of its means to science and they are distributed among several main sponsors, for example the Max-Planck-Gesellschaft in Germany or the National Science Foundation or National Academy in the United States.

The universities should be ensured a degree of stability since it takes two hundred years to shape a university and it has some status only after three hundred years, so it should be allowed to grow like a redwood.

Distribution of financial means in a centralised manner, i.e. from the highest state level directly to all the institutes in Poland, and in the case of grants to particular scientists, cannot yield good results. Should this method bring good effects, it would certainly be introduced in many highly advanced Western countries. In the West, these means are much higher; besides they are distributed from many sources. Centralisation precludes a proper control of conducting research and the assessment of the weight of topics proposed. One central institution cannot possibly take the right decisions regarding all the topics that are proposed by all the institutes in the country and by thousands of scholars applying for grants. Even the formal assessment is impossible, not to mention the subject-matter aspect.

We are also witnessing the separation of rights from responsibility, which causes many pathological phenomena. The KBN has the right to assign money, but the responsibility rests on the director of the unit. There is no such a separation anywhere in the world. The same applies to the scientific structures of the higher rank. The Polish Academy of Sciences is responsible for its 80 institutes, but it has had no influence whatsoever since 1990 on the financing of these institutes. The managers of PAN do not even know what funds are allocated to the particular institutes; however, they have to assess them under the statutory responsibility. In this sense, the system gives rise to profound abnormalities. One may not exact responsibility without providing the means for performing these duties. Besides, the whole system leads to immense dissipation of money as well as to atomization of the scientific milieu.

The previous system had a number of shortcomings, but it had also many undeniable virtues. It enabled the undertaking of large complex programmes by numerous teams coming from various institutions. It was coordinated, accounted for and assessed by teams of specialists. Decision-making concerning the financing of the particular teams took

place at the lower level. The system was also propitious to integration of scientific milieu in the given discipline of science. However, its main disadvantage was that it was the only one. This had to lead to its degeneration and so it happened. As a result, several hundred central or net programmes appeared in Poland. This contradicted the idea for which they were introduced. From this point of view the criticism of that system was right and justified, but in making a new system its virtues might be used and transplanted to the new system. By rejecting all that was in the past, *the baby was thrown out with the bath-water.*

It seems that liquidation of governmental, net and ministerial problems was not a good idea. The system had been elaborated for many years and when it started to function well, when accidental topics were removed and the poorest were left out, the wave of the "revolutionary" enthusiasm smashed up this institution. And this was a good system of financing science in the disciplines representing a good level since each system depends on the level represented by the scientists. If this level is low, each system will malfunction. At any rate, the previous system was so good that it is being largely restored now by the KBN (though it does not admit it). There was also a different and better system of accounting and acceptance of the results by the commissions as it eliminated weak scientists. At this moment, though, it is not certain whether anybody reads the reports submitted and if their subject matter is analyzed. The previous system of financing science was comparable to the system of contracts in the West.

The commissions established to assess the projects of grants do not fulfil their tasks. The means are often granted for small topics, like contributions, or quite idle topics. The manner of means allocation consisting of the individual procedure and different time of consideration of applications leads to the lack of coordination as regards the subject-matter.

Outlays on science, amounting to 0.5% of the state budget, are catastrophically low and must be increased. However, greater control is needed as regards the utilisation of the means allocated. One of the most distressing moments in the life of a researcher in the United States is so-called "site visit" of the representatives of the institution allocating a grant in the recipient scientific unit. If the visit appears to be negative, it loses the means for further research. What Poland needs is precisely the system of such "site visits" and scientists must not confine themselves to writing formal reports upon the termination of the grant. It would also be worthwhile to establish an institution patterned after the Ame-

rican Office of Research Integrity which would control the coherence of research conducted in the various institutions.

The view was also expressed that grants should not be a supplement to salaries, but ought to be used to employ new workers. Grants, however, are usually used to support salaries. This is a must stemming from the financial situation of research staff. But this, firstly, distorts the idea of the grant, and, secondly, creates a bad situation because the institute becomes the place for realisation of the grants. The institute, which for over twenty years very carefully tried to transform itself from a number of workshops and small departments into a unit with a definite research profile carrying out a definite programme, is now losing its identity. And it is untrue that every scientist was assigned a definite task, but a certain research field was outlined in which everybody was interested.

At present, the realisation of the programme of the unit is becoming more and more the issue of the director, while the scientist is interested is the realisation of the task for which he is directly responsible, that is the grant. As a result, what we observe is not only the phenomenon of thematic dissipation but also of a simultaneous transfer of the accent of research interests.

The role of grants as a factor in staff stabilisation of the units meets with controversial opinions. It is often emphasised that their main shortcoming is the fact that they are not given to the institute but to the individuals or teams. This often leads to disintegration of the institutes. It should also be said that the number of grants is smaller now than that of the to-order works in the 1980s, which causes that the number of persons taking advantage of extra financing is very limited. It is also held that decisions on allocation of grants are too often determined by biased opinions of the competing scientists. This causes that many professors give up applying for the grant in advance and seek individual orders beyond science. This is disadvantageous to the assistants who do not take part in the research work and are left to themselves. They, too, take up jobs which have nothing in common with science.

Grants are necessary, but they may play only a supplementary role. It should be borne in mind that important scientific discoveries were the outcome of large and complex research programmes. The method of financing science through individual grants, when the knowledge no longer lies on the surface and the making of discoveries requires large amounts of money and big teams, is completely ineffective. The research carried out within the framework of the grants passes unnoticed on the world scale and the world development would not be retarded if they did

not exist. If, however, the system of financing science in Poland enabled the research that might yield considerable effects, our contribution to the science world would be greater.

Some universities, technical in particular, have considerable income from their scientific-research activity, including that coming from the enterprises, since in the past two years there has been quite clear animation of contacts with enterprises and increasing number of orders for research from various firms. Some industrial sectors, e.g. cement and glazier, earmark considerable funds for research. Some plants in heavy industry are automatizing the production process. There are also orders from abroad, for example from Koszyce in Slovakia, where one of the Polish universities carried out automatization of blast furnaces.

Some universities, however, are unable to cope with the new situation. For example, in one of the technical universities, the incomes from to-order work in 1990 constituted 16% of its budget, while in 1993 — only 6.5%. The reason for this is the impoverishment of big enterprises, emergence of many small and medium-sized firms oriented to quick profits, as well as "psychic" barriers of research staff reluctant to take up "trivial" scientific problems.

There are also some orders from private industry, but the latter needs only expertise and opinions, the most important thing being the stamp of the relevant university. So far, there have been no orders for more in-depth and long-run projects.

In almost all universities and institutes the annual increase of means is lower than the rate of inflation. For example, in 1944 one of the ministerial institutes received from the KBN only 12% money more than in the previous year, while the rate of inflation amounted to some 30%.

According to some opinions, the level of financing in Poland of good scientific centres is not bad, and the Polish scientist, sometimes even not of the highest rank, spends much more money on foreign travel than the American scientist. Thus, these frequent complaints about the tragic financial situation of Polish science are not wholly true.

Rationalisation of expenditures may be a way to alleviate financial difficulties. To that end, the financing is being decentralised and the divisions are taking over tactical decisions, including those concerning salaries. This leads to the growing responsibility and to a more in-depth assessment of the workers' efficiency and personnel demand.

All the universities try to increase their incomes. In some cases, extra-budgetary means obtained are already of importance, constituting 15%–20% and sometimes even 50% of their budgets. These means mainly

come from charges for postgraduate and evening studies, but also from the letting out of rooms and from the services for other institutions. A large portion of the means comes from the KBN subsidies and from the international programmes. All this supplements an insufficient subsidy from the Ministry of National Education.

Foreign research programmes supplement only a small part of the budgets of universities and institutes, but many units make use of them. The respondents highly assess the didactic programme TEMPUS, which allows the students to undertake one-term studies at good European universities, permits short-term travel by the professors as well as the purchase of didactic equipment. TEMPUS allows for a wider opening towards Europe. The students' motivation and their attitudes towards learning foreign languages have changed.

In universities, it is important to generate certain mechanisms which would encourage professors to gain money. A profound decentralisation of the university finances is a way of rationalisation of incomes and expenditures. In many a case, the deans receive money from the subsidies of the Ministry of National Education according to some predetermined principles; almost all the reserves were liquidated, that is why it is well known that there will be no extra money. This makes the faculties seek additional funds. The deans will not do it by themselves, so they have to generate the same mechanism in relation to the heads of departments, research groups, etc. It is also important that while assessing research staff the gaining of money is viewed as one of the most positive elements. In normal conditions, the gaining of funds indicates a sensible activity of the scientist because nobody will allocate funds on mutual terms only.

The situation of the ministerial institutes is the result of the situation of the Polish economy and of a low position of Polish science. The fall of orders for scientific research from the institutions which used to place many orders is a specific problem. Against this background, the policy of the state does not, alas, help to overcome the crisis. For example, much has been said about the need for restructuring science, but if some means are allocated to the institutes that carry out restructuring, this money is usually used to discharge the employees and pay dismissal money to them. Foreign capital does not foster the increase of demand for the products of Polish science either, since it has not yet shown its readiness to cooperate in this field.

9.4. Salaries

All the respondents complained about catastrophically low salaries in higher schools and research institutes. For example, the salaries in the University of Warsaw in 1994, compared with 1989, fell in real terms by 50%–60%. In the case of professors, this is exactly 52% of what they earned in 1989. The assistant and adjoint professors earn some 60% of their salaries in 1989, so that these groups of employees have lost a bit less. In the past, the wage level of the adjoint professor equalled the average wages in the six production sectors, but today it is much lower, and the salary of a professor fell to reach this level. Generally speaking, a university job is unprofitable, but the situation varies depending on the field of research.

Certainly, a radical salary increase does not depend on the universities; however, they do have some possibilities of manoeuvre through better utilisation of extra-budgetary means. Thus, some faculties have undertaken certain measures. They ensure the top level of salaries they are allowed to pay, and at the same time extra income from grants or from classes and lectures given at extramural, postgraduate and evening studies.

In order to improve material conditions of the employees, some universities are trying to reduce the number of obligatory teaching hours. Others take quite different measures. One of the technical universities wants each employee to have a full number of obligatory teaching hours as well as extra hours to be paid 25–75 thousand zlotys per hour to the assistants and 56–120 thousand to the professors. Research staff is unwilling to work overtime and protest against such low paid jobs, but — as the respondent said — they do work. Let us mention that in the private schools a teaching hour can cost as much as 600 thousand zlotys.

The difference in earnings between private schools and state-owned universities is, officially, considerable. Actually, however, it is a bit smaller because the universities, forced by this competition, must pay their employees extra money from the additional means they earn. A teaching hour is usually paid 300–500 thousand zlotys above the obligatory teaching hours. In sum, the difference does exist, but it is no longer so great. The private schools began ambitiously, but the market is shrinking as there are not many people who can afford 20 million zlotys per one semester. Thus, the state-owned universities do not complain about the lack of candidates, including those for paid studies, because the charges are substantially lower.

However, the incomes of university employees are fairly uncertain and they cannot guarantee stabilisation of the professional career.

In many institutes of the Polish Academy of Sciences, after the recent change of the salary range, only the lowest salaries could be offered to all the employees — from the assistant to the professor. At this point, the motivation function of the salary, which was already symbolic, ceased to exist.

The average salaries in the ministerial institutes are very low amounting to 4.8–5.0 million zlotys, while extra incomes are hardly possible. Some institutes do not pay the honorariums from the grants and these sums are included in the wage fund. To compensate for a sense of wrong to those employees who did obtain grants, 500 thousand zlotys were added to their monthly salary.

Some institutes, in order to improve the material conditions of their employees, cut down the margins of general costs of the to-order work to 10%–20%. In some institutes, however, restrictions are greater and the employees have to finance first their own wage fund (up to 30%) from the grants and to-order work, and then what is left may constitute extra earnings.

9.5. Equipment

The opinions regarding the equipment of the particular scientific units are highly differentiated. The collapse of Polish industry after 1989 has caused that a large portion of the laboratories that had been constructed, particularly in technical universities, for the purpose of servicing concrete enterprises are not utilised. On the other hand, the poverty of the universities and shortage of funds for the experimental equipment has an adverse impact on the level of qualifications of their graduates. The lack of equipment and money for salaries of the engineering-technical staff causes that doctoral and postdoctoral dissertations are becoming increasingly theoretical. They are based on computer simulation, but they cannot take account of the various factors that might be perceived solely during recurring experiments. This is all more the dangerous as the contemporary technical sciences are largely oriented towards technological improvements in an experimental way. The most guarded technological secrets today are the results of long-lasting experiments in laboratory conditions. This leads to a peculiar loss of qualifications and skills and to the widening gap between Polish and world science.

In many institutes, most equipment was purchased in the 1980s, when the units coordinating central programmes of fundamental research might assign fairly substantial means for equipment. Today it is old, but, unfortunately, grants from the KBN allow for a small margin of expenditure for equipment. That is why the equipment of many institutes is being constantly downgraded. The housing conditions, especially in some ministerial institutes, have improved considerably due to a reduction in personnel (sometimes even by 30%–40%). Some institutes let part of their rooms, thus having the means for their functioning from the rent.

The degree of PC computer equipment in the units is good. If these are 486 computers, they will be operating still for several years to come. It often happens, however, that there are too many computers. The unnecessary expenditures for computers in the past three years in Poland are said to amount to 2 billion zlotys. The example may be given of the recent purchase of four American super computers (CRAY) from the KBN means despite advice to the contrary by representatives of technical sciences. These are extremely specialised computers and there is hardly any chance that they will be used in Poland for the purposes they were designed. It seems that the American offer of selling partly abortive equipment has been accepted rather uncritically.

The institutes, however, never had enough money for the subscription to scientific periodicals. The scientists are unable to follow current literature.

Good institutes are quite well equipped, although the equipment is slowly ageing. When the previous system of crucial and ministerial problems was coming to an end, many units bought a good deal of equipment. There are, however, some units which have workshops comparable to the Western ones and there is no drastic difference in the level of equipment. Many units view the last five years as probably the best period as regards the purchase of equipment. Some respondents stressed that its accessibility is extremely important. In the previous period, one might have large sums in zlotys, but they could not be used as the units had to buy outdated equipment in the former GDR or in Hungary. At present, modern equipment can be bought everywhere in the world; the zloty is a normal currency and this also gives great benefits.

Besides, the scarcity of means causes people to rationalise expenditures and jointly apply for some equipment; for example, a growing cooperation within the milieu can be observed quite clearly. In Cracow and Poznań the heads of the units keep in touch and do many things in cooperation. In Cracow, e.g. the computer network has been installed

for the entire milieu and everybody has on their desk access to the Internet, i.e. connection with the whole world. The Cracow scientific milieu has also received funds from the Mellon foundation and is now applying for the KBN funds needed to complete the computerisation of the libraries, which they had started with their own funds. The net makes its realisation possible. Cracow has $1.5 million for the computerisation of libraries which are likely to reach the world standard within one or two years.

9.6. The situation of the staff and its conditioning

There are few young people taking up scientific jobs. There are two reasons for that. The prevalent opinion is that the salaries of research staff are humiliating. Besides, young people do not want to dedicate themselves to the activity in which many years of hard and fully absorbing work does not give any financial equivalent enabling a normal life. But it is not the only factor. The second — very important — reason is the fact that the road to a scientific career in Poland is a very long one. In the experimental institutes of medical colleges it takes incomparably longer to make a career than it is the case abroad. This is related to old, ill-equipped workshops and bad organisational structure, which is outdated and anachronistic. All this means that before a young man achieves satisfaction of being a scientist in his scientific career, the life has already passed. In other disciplines this satisfaction can be achieved much earlier. Today, the young university graduates want success faster. The time of the previous generation already belongs to the past.

At present, the passage to other occupations at home is incomparably more dangerous for the universities than the external brain drain. This applies to many humanistic faculties, especially law, administration and management, but also some others, such as psychology or sociology. The employees of these faculties are offered much better jobs in industry and in private enterprises than in the universities. There has been a considerable outflow of personnel. These people sometimes continue working in the university, but they are inefficient. This phenomenon begins to prevail over migration which was previously quite numerous, especially in natural sciences.

Thus the main problem is not the brain flight from Poland, as it used to be in the previous years. Now the main danger we are facing is the passage to other occupations in the home country. For example,

one of the departments of the Medical Academy has lost its four best persons who took up jobs in the branches of pharmaceutical firms. In all countries of the world jobs in industry are very attractive and many scientists combine university jobs with industrial jobs or even pass to the latter. There is nothing wrong in it. However, the problem lies in an outrageous disproportion between the earnings of persons who work for pharmaceutical firms and those of the research staff. Earnings in industry are higher all over the world, but in Poland this difference is shocking. The incomes of representatives of pharmaceutical firms are at least 10 times higher, and if we take into account other profits, like, e.g. the use of cars, the increase may be 20 times as large.

The greatest outflow from medical colleges can be observed among the pharmacists, of whom large numbers move to the private pharmacies. It this trend persists, soon there will be no sufficient staff to train students in this discipline. Many research staff also leave such faculties as radiology, forensic medicine and pathomorphology. It should be emphasised that the persons leaving have the highest qualifications and within 2 or 3 years there can be an insufficient number of people able to hold managerial posts in some research units.

In some medical colleges, where the fluctuation is very small — as one of the respondents told us — the reluctance to leave a scientific job is related to the situation on the labour market of physicians. Since many research staff in medical colleges have a private practice, employment in the clinics provides unique diagnostic conditions and gives great authority. Private consulting rooms often have only a physician and a nurse, while the job in the medical college facilitates access to sophisticated equipment and scarce hospital beds.

The number of offers at home has considerably increased. No one knows whether a mathematician or biologist will be a director of the bank or head of the laboratory. In the previous period, mathematicians, physicists and chemists traditionally worked in the laboratories or in schools. At present, a chemist may be a representative of a cosmetic firm and earn much more than his laboratory colleague, while mathematicians are employed in banks. It seems that the "crazy men" dealing with, let us say, theoretical physics, are not taken by the banks from the universities, but there are some problems in those faculties where good financial opportunities opened up, e.g. for the lawyers, economists, and specialists in organisation. The assistants do not work long there, because a young lawyer doing his apprenticeship in the legal profession gets the same salary as a professor.

In ten institutes directed by one of the Polish Academy of Sciences divisions, the number of the employees fell by 30% over the past three years. The staff who attained the retirement age automatically retire, but the new staff are not employed since the institutes have no money. The salary of the adjoint professor who has had his doctoral degree for several years amounts to 4.2 million zlotys, and it is lower than the wage of officials who are graduates of the secondary schools employed in the Academy, and who earn 5 million zlotys and more. Many institutes of the Academy, had to discharge 20%–30% of their staff, the specially protected research staff being reduced by 14%. These are workers with a doctor's and postdoctoral degree in the education of whom the institutes invested a lot of money. The losses due to the leaving of jobs by these workers are then much greater than the figures show. This leads to the ageing of the staff and it happens that the youngest worker at the institute in question is forty years old.

In the ministerial institutes, like in other units, there is a quite clear generation gap. One of the ministerial units succeeded in slowing the increasing average of its workers' age in the last three years and the age averages now slightly above 40 years. The same unit might employ 25–30 young people. Unfortunately, there are no candidates due to low salaries. The greatest outflow of the staff occurred in the period following martial law. A sizeable percentage of persons who were discharged for various reasons at that time went abroad. After 1990, foreign migrations rapidly decreased.

In the academies of economics, as well as in other higher schools, there are some characteristic phenomena. Firstly, there was a great wave of outflow of the research staff to the banks — first Polish and then foreign — as well as to private firms. Secondly, the scientists take up full-time jobs in various economic institutions, and continue to work part--time in the higher schools. The latter have to tolerate this because they are unable to fill the personnel gap. If a worker is able to combine two jobs, his work in the economic practice and the knowledge acquired there may be of use for the students. It often happens, however, that the employees have so much work to do in the banks or other institutions that they do not have time for the students and this is detrimental to the level of instruction. In many schools at least half of its employees (and almost all the professors) have extra jobs. Thirdly, many employees set up consulting firms, either individual or in cooperation with foreign partners. A number of schools offering courses in management, banking and insurance have also been established. For example, in Poznań there

are three schools which "prey upon" the lecturers of the state-owned universities who give lectures in these schools, usually on the same topics as in the economic academy. However, there have been some attempts at cooperation with the private higher schools that fund e.g. doctoral scholarships for persons who will work for them in the future. The schools will also spend money on the development of the state-owned library since it is accessible to their students.

Various measures are taken, often bordering on legality, to keep the employees. One of the medical colleges pays extra money to its workers from the so-called statutory activity. This is the only way to keep the employees of theoretical departments who earn two or three million zlotys per month and have families. In 1994, the system of the so-called "individual subsidies of statutory activity" was created, which is a unique solution. These are special extra subsidies assigned by the rector amounting to three million zlotys per month, which may improve the material situation of young research staff. This sum of money makes many of them stay at the university. The other way of increasing the incomes of the employees are grants.

There is also the problem of offering higher salaries by the foreign firms to graduates who might be employed as assistants by the university. To counteract this practice, intramural doctoral studies are offered. It is likely that some persons will then continue to work for the university. Attempts are made to negotiate some obligations, but with no guarantees because foreign firms offer much better conditions.

The university graduates are reluctant to take up scientific jobs, so all those who want to stay in the higher school, are employed. In order to encourage them to do so, jobs are offered to them already during the last year of the study, so that a newly employed assistant may combine the job with the studies. After one or two years, however, some 75% of the assistants give up a scientific job. Those who continue to work seek additional occupations and are not interested in writing a doctoral dissertation at all.

The exact directions, except for Warsaw, do not face greater difficulties with employing assistants, but there are great differences in the faculties of law and economics. Some fields face a menace to staff reproduction (mainly law and economics). The percentage of poor postdoctoral dissertations is increasing because the pressure from some institutions causes that the councils of the faculties are more liberal.

There are, however, institutes which employ people on the basis of positive selection. They include even physicians, although in the past

10–15 years it was easier to employ a chemist, biologist, mathematician or electronics specialist. This is, however, only an apparent improvement since — after they get certain qualifications, usually a doctor's degree — they pass to the various pharmaceutical firms manufacturing scientific equipment, reagents, etc. These are evident losses because quite a lot of money was invested in these people.

A great deal depends also on the managerial staff of the scientific units. As is well known, the director of the institution should represent a definite psychic type of man who must acquire means for his institution, and, in fact, this is the only thing the director of the contemporary institute should be able to do. Actually, the managerial post should not be combined with scientific work.

The higher schools as potential work places are certainly not competitive vis-a-vis the free market economy sector. However, their specific character provides better conditions for extra earnings than other establishments. This concerns scientific research, but also intensified and commercial didactics which allow their staff to earn extra income. These persons can double their salaries thanks to this teaching activity. Besides, there are no limitations as regards the combining of work in the various schools. One can even take up one and a half or two full-time jobs and we know of such cases. But working half-time is widespread. The higher schools also allow for temporary contracts with the various private firms, which permits the ablest persons to gain a considerable extra income. And finally, the employees of the higher schools may get annual sabbatical leave.

Unlike the big towns, in small provincial centres there is no great competition between science and other sectors of the economy, but there is a competition within the sector of science. For example, in one of the higher pedagogical schools during four years the professorial staff increased by 13%. 30%–40% of the increase accounted for the development of their own scientific staff, while 60%–70% of scientists came from the outside. Those people came from such higher schools as the University of Warsaw and Jagiellonian University and took the first job there, first of all for material reasons. The school offered flats and even one-family houses for titular professors. The local authorities view the development of higher education as the priority and make efforts to establish a university in their town.

In some higher schools staff is supplemented by foreigners. In one of the towns in southern Poland they are working both in the technical university and in the Higher School of Education which employs more

or less one-third of all those who apply for jobs. There are many applications, from Lvov in particular, so a selection can be made. The Higher School of Education employs foreigners in three institutes: of technics, physics and Russian philology (with specialisation in English philology). Each student of Russian philology has to take courses in English or in German. The latter institute employs one professor from Baku and one assistant professor from Moscow. These are the specialists of the highest rank. Most foreigners come from the former USSR. The directions of the exact sciences employ two members of the former Academy of Sciences of the USSR. One of the professors is even a member of the Academy of Science and Arts in New York. The foreign scientists are employed for at least two years, since — according to the recommendations of the Main Council — the foreign employee is reckoned under the obligatory minimum indispensable for the master's studies only when he has a contract for at least two years. The scientists from the former USSR understand Polish well and learn to speak it very fast. Some of them come here with their families.

Many respondents say that the number of doctoral and postdoctoral degrees in their schools has been declining. While in the 1980s 200 doctoral dissertations were defended annually, today this number has fallen to 80. In other cases, the number of the scientific degrees conferred has not been recorded.

The experimental faculties face the shortage of good young candidates. There are two reasons for that. Firstly, the candidates for these directions are already slightly selected and less ambitious; secondly, it is the specificity of these disciplines. These are classical fundamental sciences with no direct connection with social practice. In such cases, a negative selection takes place and the persons with the least ambitions stay in the universities, seeking such facilities as a long leave and unfixed work time. Only a small percentage (some 10%) includes those enthusiasts who developed their interests during the study and want to be scholars at least in this first period. These persons pose a different problem. The higher schools invest money in them, by creating, for example, a very expensive workshop for them, and then they change their mind and say: *thank you, this is no longer of interest to me.*

It seems that in neophilologies the situation begins to stabilise and the losses are smaller now, since the demand for people with practical knowledge of foreign languages — at least in the big towns — is approaching the state of saturation. Teachers are not in such great demand

anymore, and even if they are, the people involved prefer to take up a second job outside the school.

The situation is extremely dramatic in informatics; it is still worse than in the faculties of law because law is certainly an important discipline of knowledge but also of practice and the reproduction of the staff there — after a certain decline — will soon recover. However, the situation in informatics is more alarming since informatics has become indispensable for many fundamental sciences and the inability to pay good salaries to the informaticians diminishes research capacities of the experimental sciences which is disastrous to them. Nothing can be done to keep the young informaticians in the universities. Neither half-time employment nor overtime can help. Graduates from informatics, already at the beginning, are offered salaries four times higher as compared with university salaries. The lack of young personnel in informatics is a catastrophe because with this rate of quality increase the knowledge can by no means be supplemented by training people who have already had training. The informaticians with doctoral degrees are unable to learn new informatics.

If this situation persists, in the years 1996–1997 we shall face the beginning of the personnel collapse. In some universities, the fall in the number of doctors is likely to reach 30% or even more. The same applies to postdoctoral degrees. In order to hamper this setback, the salaries should be doubled or tripled, and the subsidies for material expenditures of the higher schools ought to increase by 50% at least.

9.7. Academic career

Profitability of a scientific career is relative; in order to gain profits from a scientific career, one must work hard for a long time and attain higher positions. Profitability of a scientific career is much extended in time. It is surely not profitable for a young scientist with a family to support. If, however, the assessment is made throughout a lifetime, the situation looks different. But young people are impatient and this is understandable. Neither can scientific work be viewed as a profession. Science means something more: one must like it and it must be his passion; secondly, the minimum of the talent is indispensable, and, thirdly, a great deal of work must be done. If someone treats science as a regular profession which allows one to earn money, the likelihood of disappointment is quite high.

There is always a certain percentage of the university graduates who take interest in carrying out research; they are so much interested that they take up a scientific job no matter what amount of money they are offered. This is the most valuable material. At the same time, their teachers bear great responsibility for such diamonds.

Great scientific achievements of the Poles, for example in astronomy, rarely take place at home. The telescopes that are needed for this purpose are available only in the United States. The situation is similar in high energy physics or in physics of elementary particles which require huge, extremely complicated and expensive equipment. These disciplines develop exclusively under the international cooperation. No country, even the richest one, can afford some equipment. There are many centres in the world, e.g. in Geneva or Hamburg, where Polish scientists work and make a remarkable contribution to the research conducted there.

It is also important that those who migrated to the USA from one of the leading medical institutes do not clean the streets or work as waiters. All of them are employed in the scientific institutes and most of them work for the units of renown in the given discipline. Only some of them changed their specialisation and they keep publishing in good periodicals. Only one person passed to the production of medicines and partly left science. Several Polish scientists have built an excellent career.

One of the examples of a great career is Henryk Wiśniewski, who migrated as early as 1970 to Great Britain, where he won an international contest for the post of a director of the institute amongst 80 candidates from all over the world. Then he moved to the USA, where he also won the contest, thus inheriting the institute from an outstanding scholar. This was a fairly old-fashioned unit at that time. During twelve years he turned it into an institute of the world renown in neurological sciences. This is a great career which was started in the Institute of Experimental and Clinical Medicine of the Polish Academy of Sciences. Another employee of the same institute, an engineer in electronics, made also a great career as he became a neurophysiologist and later on he got involved in the research on the artificial heart and is working in the university of Los Angeles. On the one hand, this is a loss, but on the other hand, a reason for pride for the Institute. The fact that many people could easily find employment in good institutes of world renown, shows that they had learned something in Poland.

9.8. Scientific achievements and the future of science

The position of mathematics varies. Twenty-five years or so, a certain error was committed. Mathematicians dealt with the traditional paradigm for too long. At present, however, teams of young people are established, for example in Poznań, where Tomasz Łuczak, aged 32, has recently been granted a professorship. These teams develop those disciplines which were not represented in Poland. Meanwhile, the Institute of Mathematics of the Polish Academy of Sciences, the hitherto leader, has aged and did not even notice that things look different in the world. And yet Polish mathematicians are still being "bought" in the world.

For example, the Institute of the Fundamental Problems of Technics has designed an original ultrasonograph which has already been sold to 46 customers since last year. Besides, the team won the contest of the Ministry of Health for the supply of public health care with 30 pieces of this apparatus. Another great achievement is the apparatus for examination of blood flow, constructed in the same institute, which has aroused interest on the part of NASA. The Polish apparatus for measuring strains in the rails, received the highest mark in the United States.

However, in Poland there are no well-established mechanisms of search for such achievements, their support and promotion. The industry, due to its difficult situation does not show major interest, and the authorities cannot or do not want to do this. The emerging private companies in science, which are burdened with taxes like other economic subjects, are not likely to fulfil this task. What we need is a solution comparable to the American contests for new technologies, which are a forum for the presentation of new solutions. As a result, these solutions may be noticed both by decision-makers allocating financial means and by the enterprises. Projects or teams that win such contests receive extremely high subsidies for which they have to account in detail. Nobody proposed a similar solution in Poland. It is disastrous for Polish science that all the managerial posts are held by persons with specialisations detached from practical life.

Medicine is more traditional than other directions, but it is also facing the generational changing of the guard. For example, the Department of Genetics of Man is run by a 42- or 43-year old scientist, who holds this office for the second term so he was appointed head in his late thirties. The Nencki Institute in Warsaw is also run by a young man and all the directors are young, although it used to be a very traditional institute with a large number of old professors who continue to work but have

given the management into the hands of young people. The same thing happened in the Institute of Pharmacology in Cracow. It is similar in the universities. In Warsaw, for example, the chair of neurology was taken up by the youngest candidate.

Many higher schools undergo restructuring and modernisation of the teaching process. For example, in one of the faculties of mining, apart from traditional specialisations, the economic direction was opened; it trains specialists in the management of the mining industry and it became very popular. Another direction is the underground building, i.e. building of tunnels, underground railways. It has its specificity which is unknown to the engineers of the overground building. Part of the staff managed to change specialisation and propose a new direction, which became very popular among the candidates. This is how people adapt themselves to new conditions. Students of traditional directions are in the minority in this college. For example, one-third of the students learn electrotechnics, automatization, electronics, communications and informatics. These are "fashionable" directions which can enrol one-fourth of the number of candidates. Technical schools develop other discipline, e.g. economics, and they tend to become technical universities.

For example, the Academy of Mining and Metallurgy in Cracow has a well-organised faculty of economics which has been mentioned in the ranking list of the weekly "Wprost" as the only one amongst technical universities. The faculty concentrates the highest number of the best students and the number of candidates is four times larger than it can enrol. The Faculty of Management and Organisation of Production has the right to run studies and confer doctoral degrees in economics in two fields, i.e. management and economics. This university also has a large Institute of Social Sciences in which pedagogical courses are very good and students often choose them to obtain teacher's qualifications. Some disciplines, eg. sociology, are oriented to specific problems of industry. This university also intends to set up the humanities faculty with the focus on the problems of technology and industry, which would offer courses in psychology, sociology and education. Besides the university has the right to offer courses in the earth sciences and physics. The Faculty of Physics is one of the best faculties in Poland and the Ceramic Faculty is fully licensed to offer courses in chemical sciences. Thus, the university does not confine itself to technical faculties.

One of the technical universities is restructuring its scientific activity. The four main directions of research have been outlined: new materials and surface engineering, automatization and technique of information,

bio-engineering as well as energy in environmental protection. The research work is conducted by the teams of scientists of the various faculties. This gives rise to interdisciplinary research centres which are likely to take the form of institutions in the future.

Nevertheless, the pessimistic opinions are prevalent. One of our respondents said that in view of the current financial situation there are poor prospects for development of many medical academies, which focus on survival in the domain of the training of students and clinical treatment. Medical academies are schools in which training cannot be separated from treatment; hence medical academies suffer both due to the shrinking means for treatment and due to the shortage of means for the scientific research, for the equipment in particular. For example, in 1994, one the medical academies was granted 10 billion zlotys for the equipment, but it had to give back 9 billion on account of purchases in 1993. Thus, students cannot be trained using the most modern equipment, which evidently affects their skills.

At present, two phenomena can be observed. The first one is decreasing migration abroad. The best scientists have already left, while the new and able do not grow in number. The second phenomenon is exactly the lack of inflow of young people willing to devote themselves to a scientific career. If young people hear nothing about science in the mass media, and if they do not hear any statements by the representatives of political elites and government, which might indicate that the role of science is appreciated, being on the threshold of choice of their road in life, they choose a business career. The cult of money is spreading. The positive hero of our time is the entrepreneur and not the scientist. The generation gap begins to manifest itself. In the coming years it will not be dramatic yet, but in 10 years the problem of the lack of scientific personnel will appear with great severity. This will push the possibilities of Polish science back by decades, which means a catastrophe for Poland in view of the world scientific race. The losses suffered by Polish science so far are irreversible, even if the authorities suddenly came to the conclusion that they must improve the situation of Polish science.

The discussion concerning science policy usually focuses on the need for implementation of scientific achievements in industry. This, however, was done during the last 40 years and it turned to be a failure. Enterprises do not want to make use of new solutions which have not been tested yet because of the immense costs, which is confirmed by the experiences of many countries. Enterprises take a certain risk only when they hope for great profits, as was the case with the Apple computer, or they are made

to accept novelties when they face threat from competition. These are the only factors which can make enterprises take an interest in novelties. The Volkswagen concern had to change the management in order to replace the old car model with the production of a new one (Golf). General Motors faced a similar situation. Nobody has realised this in Poland so far. The old thinking about the implementation of inventions in industry is still predominant.

If an institute has a team of persons who have significant achievements, their work should be followed by the specialised agency, for example in the case of the institutes of the Polish Academy of Sciences by the offices of the secretaries of Divisions. This constant observation would enable them to take decisions whether the given research work should be supported or whether the financing should be discontinued because it does not lead to desirable solutions. What is going on in Poland now is a real tragedy.

Conclusions and Recommendations

The study of the external and internal brain flight conducted in 1994 led to the following conclusions:

- Contrary to popular opinions, or even judgements of experts, permanent migrations of Polish scientists in the years 1992–1993, as compared to the period 1989–1991, did not decrease but even slightly increased. In the early 1990s the average annual number of migrants totalled 191, while in the second period it already amounted to 218.
- The external brain flight, however, causes much fewer losses in scientific and university staff than the passage to other occupations in the home country. While in the 1980s the internal brain flight involved 286 persons annually, in the early 1990s it already encompassed 1088 persons.
- Most people moving to other occupations at home come from such disciplines as economics and management, mathematics and informatics, social sciences and law, as well as biology. Scientists migrating abroad include mainly biologists, mathematicians and informaticians, physicists as well as chemists, that is mainly representatives of exact sciences. The majority of scientific migrants came from the Polish Academy of Sciences, medical academies and technical universities, while most persons taking up other jobs at home were former employees of the Polish Academy of Sciences and of the ministerial institutes.
- Research staff migrating abroad for good find jobs in science much more frequently than in the 1980s. Formerly, people migrated mainly for political and economic reasons, since in the latter case the work abroad, even in case of a low ranking job, was highly profitable. Today, an important motivation for migration, beside economic reasons, are possibilities of finding better conditions for scientific work.
- Scientists moving to other occupations at home find employment mainly in private domestic or foreign firms, and some of the former research staff start a business of their own.

- Due to migration and passage to other occupations at home, Polish science and higher education have no losses in the number of employees, since — except for some institutions and disciplines — vacancies are occupied by other people changing work places within the sector under study or by the graduates. However, the losses in quality are evident, since the persons leaving include mainly those having doctor's degrees in whose education the universities or scientific institutes invested quite a lot of money; besides, those who leave are the most gifted and dynamic persons. In all higher schools there is a growing number of workers taking up several jobs, who often treat their university job as a secondary occupation. Many graduates taking up jobs in the universities stay only during the period of writing a doctoral dissertation, which is often a "pass" to further extra-scientific career.
- Many researchers and scientists continue to work in universities also because the job gives them a "visiting-card" which is welcome mainly in the consulting firms, banks and other private firms. Others treat it almost as a condition for working on their own account. This applies, for example, to physicians employed by medical academies, who examine their private patients in state-owned diagnostic centres and treat them in clinics. All of them enjoy a certain prestige due to their employment in higher schools.
- In the majority of cases, however, graduates remaining in the higher schools are the least gifted and dynamic. Thus the universities and scientific institutions are facing a well-marked phenomenon of negative selection.
- Due to the widespread practice of taking up several jobs and to negative selection, in many disciplines the level of lectures and classes is decreasing; besides, they are sometimes conducted irregularly. The university authorities must "shut their eyes" to this lack of discipline not to lose the rest of the employees. The most difficult situation is observed in the departments of economics and management, law as well as in the social sciences. On the other hand, however, if the students meet their teachers during classes, they may learn from them about the true economic processes occurring in the banks and other financial institutions.
- In some disciplines due to the lack of research staff and their poor involvement in university work, reproduction of workers with university degrees and of scientific staff is under threat. This mostly concerns the economic sciences, management, law and informatics.

- Outlays on science and higher education have been systematically declining. The means allocated to the universities by the Ministry of National Education have been decreasing now for several years. The percentage of outlays on science in the national income distributed has declined to reach 0.57%. The salaries of the research staff, in real terms, have been constantly decreasing. For example, the salary of the professor of a university in 1994 is worth half his salary of 1989.
- This situation is described by the experts interviewed as catastrophic, whereas the ways of coping with these difficult conditions are highly differentiated. A large number of the institutions, mainly universities, are seeking extra-budgetary funds. The latter largely come from the Committee for Scientific Research (means for statutory research and grants), from charges for extramural, evening and postgraduate studies, as well as from foreign aid (TEMPUS and various foundations).
- The scientific institutions and higher schools are experiencing the generation "changing of the guard" in the managerial posts (rectors, deputy rectors, deans and directors of institutes). The institutes run by the relatively young (under 50 years of age) research staff are developing more rapidly, have higher research funds, and their directors are more optimistic about the future.
- The reform of financing science, implemented after 1989, and particularly the system of grants, arouses controversial judgements. Some experts hold that the new system leads to disintegration of scientific institutions, dispersal of research and demoralisation caused by unobjective assessment of research projects. The persons who gave a positive assessment of the system of grants are of the opinion that it facilitates to keep in science gifted employees, allowing them to obtain the means for research and supplementing their poor salaries. However, even the advocates of grants hold that the latter can only be an additional and insignificant source of the means for scientific research since in their present form they lead to atomization of research teams and considerable dispersal of means, which precludes undertaking more costly team-work and interdisciplinary research.

The recommendations of the 1992 Report include the following statements:

- All specialists agree that on the threshold of the 21st century science and knowledge come to be the main development factors. A country which will not develop higher education and scientific research has no chances of being independent. In Poland, outlays on science and higher education have been decreasing now for many years. This

disadvantageous situation should be reversed as soon as possible, even though the domestic product value is declining.

- In order to avoid the catastrophe, salaries in education and science should be raised in the coming years to reach the European level. This means that they ought to be raised five to six times, which, unfortunately, is possible only at the expense of other social groups.
- Modernisation of scientific workshops and intensification of research in selected most promising directions is a must.
- Development of higher education and scientific research should become the highest priority for the state authorities.
- None of the above-mentioned demands, which were not only the wishes of the authors, but also reflected the opinions of the Polish scientists, has been fulfilled. **The successive Polish governments, being extremely short-sighted, failed to perceive the role of science and higher education in the contemporary world. Each year funds allocated to science and higher education in the state budget are decreasing, which entails a constant degradation of this sphere of human activity which is so important in international competition. Besides, the limitations are greater here than in the case of other expenditures of the state. Short-sightedness of the Polish political elite, government, parliament and political parties leads to a civilisational breakdown which will manifest itself on the threshold of the 21st century.**