UNIWERSYTET WARSZAWSKI
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8 (41)

STUDIA
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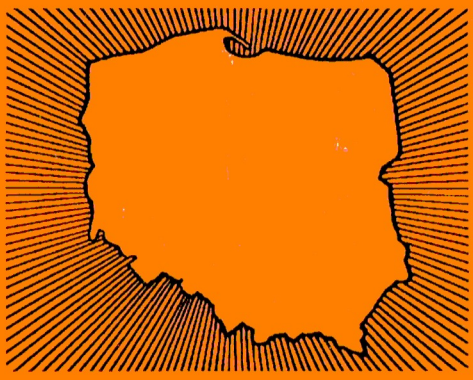

Ucieczka mózgów ze szkolnictwa wyższego i nauki

Janusz Hryniewicz
Bohdan Jałowiecki
Agnieszka Mync

Warszawa 1992

UNIVERSITY OF WARSAW
EUROPEAN INSTITUTE FOR REGIONAL AND LOCAL DEVELOPMENT

REGIONAL AND LOCAL
STUDIES

ÉTUDES RÉGIONALES
ET LOCALES

9

The Brain Drain in Poland

Janusz Hryniewicz
Bohdan Jałowiecki
Agnieszka Mync

Warsaw, September 1992

EDITORS OF THE SERIES:
REGIONAL AND LOCAL STUDIES
ETUDES REGIONALES ET LOCALES

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Editor of the volume: Bohdan Jałowiecki

ISBN 83–900283–5–2

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* The present English language report does not contain chapter 6 of the original Polish text, describing the market of the highly skilled labour in Western Europe, since these matters are better known to the Readers from the respective countries. In chapter 1 two tables were omitted presenting in detail the equipment level of scientific institutions. Likewise, a statistical appendix was omitted, which, though, can be easily made use of by an English-language reader.

Authors: Chapters 2–5 — Janusz Hryniewicz, Introduction and Chapter 6 — Bohdan Jałowiecki, Chapter 1 and Appendixes — Agnieszka Mync.

INTRODUCTION
THE GENERAL FRAMEWORK OF THE STUDY

One can observe in countries of medium or low level of development that migrations of persons with university education take a specific character, referred to in the literature devoted to this subject as the *brain drain* or the *brain flight*. The latter of these two terms has a more descriptive nature and it indicates rather the repelling factors which exist in a given country, while the first one assumes a conscious activity of some other country, aiming at attracting specialists from the country in question, and is therefore charged with definite political undertones.

The study presented here has been carried out by the staff of the European Institute of Regional and Local Development on the commission from the Committee for Scientific Research and it describes the phenomenon of *brain flight*, and not of the *brain drain*, so that we will in principle be using the first of these terms. The *brain flight* is caused both by the repelling factors existing in the economically less developed countries and by the attracting factors existing in highly developed countries.

The repelling factors are commonly held to include lower incomes gained by the research staff as well as worse work conditions, that is: poor equipment in laboratories and workshops, lack of research funds, inadequate accessibility of world literature, limited possibilities of contacting foreign scientific centers, resulting mainly from shortage of financial means, but also, in some cases, from political reasons.

The attracting factors are usually of symmetrical nature. On the one hand they are represented by relatively higher salaries, much better equipment in the laboratories and workshops, and ample funds which can be acquired for research. On the other hand, an important attracting factor is constituted by the generally positive climate for the research work, the

liberal social system, the community of scientists with whom one can exchange views and opinions, the high standard of living, the possibility of educating children in the best of universities etc.

The highly developed countries, which dispose of very important research potential, are constantly interested in acquisition of already known scientists representing high level of expertise, or of young research workers with outstanding capabilities. Since both the military complex of these countries and their economy are very absorptive with respect to innovations, their own scientific potential is often inadequate for satisfying the resulting demand. Besides this, it is much less costly to admit an educated, gifted and promising scientist than to have to bring her/him up from the very beginning, and gives the effects immediately, in distinction to having to wait for them a dozen years at least.

The highly developed countries have a well organized system of provision for the *brain drain*. The system consists in scholarships for young scientists and in inviting the known ones as visiting professors. When the guests are positively evaluated then they may be offered attractive proposals of steady jobs.

The *brain flight* cannot be evaluated unambiguously. There are, namely, two aspects of this process. Science has no boundaries, and scientific discoveries become sooner or later the property of humanity as a whole. It is therefore advantageous, from this point of view, that when a research worker who has a great scientific idea and who is not able of implementing it in own country go there where such a possibility exists. On the other hand, though, the *brain flight* may cause negative consequences in the country of origin of the migrating scientists. There is an economic and military competition among the countries. The *brain flight* lowers the direct competitiveness of a given country on the international market, and may also entail lowering of the level of education, exerting thereby, as well, a long-term influence upon the competitiveness of the given society.

The object of the *brain drain* and the area of the *brain flight* is not only constituted by the relatively less developed states, but also by the highly developed ones, which, due to their low demographic potential are not capable of developing relatively uniformly all the domains of science, like, for instance, Switzerland or Sweden. The *brain drain* may also affect large and relatively wealthy countries which, due to various reasons, are not capable of adequately competing on the international science market. This applies, for instance, to France, and in particular to United Kingdom,

the latter having lost quite a number of scientist who moved to the United States due to the restrictive policies of Margaret Thatcher.

The situation in the so called „post-communist" countries is more complex. A phenomenon, which is virtually not known anywhere else, and which can be referred to as internal *brain drain*, appeared in these countries. It consists in absorption of the gifted young scientists by the business organisms emerging in these countries. Thus, the phenomenon of the market for highly skilled labour appeared in the post-communist countries, and scientific institutions are not capable at all of competing effectively on this market. This results from the inadequacy of salaries in the sphere of science with respect to the requirements of the new situation on the market of highly skilled labour and from the significant reduction of financial means spent on research. Such a situation causes internal absorption of the most gifted and dynamic young scientists from science.

It is of course so that scientists working in the most developed countries do not attain the highest incomes neither, since the scientific institutions do not offer there the salaries as attractive as in business, but they certainly gain enough for the decent upkeep of family and their salaries are much higher than those of skilled blue collar workers. The incomes of scientists in the post-communist countries result from the hierarchy of wages inherited from the previous system. The new authorities, irrespective of the radical change of the situation in the skilled labour market, have not only maintained the previous wage structure, but have also been agreeing to dramatic worsening of the living conditions of scientists. This results from lack of understanding of the role of science in the development of the country, and also from the fact that scientists do not organize strikes nor street manifestations nor occupations of governmental premises.

Thus, both in Poland and in other countries of Central and Eastern Europe we can observe both external and internal *brain flight*. In the first case a scientists leaving the country has the opportunity of acquiring better conditions of scientific work and of contributing to the development of science, in the second case — the scientists passes to some other occupation within the country, where the incomes are much higher, and is therefore lost for science, but remains in the country. A unique evaluation of these two situations is, of course, very difficult, and it depends upon the point of view.

The report presented here shows the results of the empirical study of the phenomenon of *brain flight* from the universities and the research institutions presented against the background of general characterization of

economic conditions of functioning of university education and research. This study is the first one in Polish scientific literature referring to a representative sample and depicting both foreign migrations of scientists and the internal flows from science to other occupations. The scarcity of means devoted to the study made it possible to present only the most important aspects of the phenomenon, without the in-depth treatment of such interesting issues as, for instance, skills and domains of expertise of the migrating scientists.

In the further part of the Polish language version of the report certain aspects of the market of intellectual labour in Western Europe were presented, so as to show the general characteristics of the market and the particular features for particular countries. The phenomenon of *brain flight* in Poland could thereby be much better seen, together with its specificity.

The hope should be expressed that the report presented will also be helpful in formulation of the policies of the state related to research and to university education.

Warsaw, September 1992.

1. THE ECONOMIC SITUATION OF POLISH SCIENCE

Introductory remarks

In the literature devoted to the phenomenon of *brain flight* the following causes of this phenomenon are being usually paid attention to:

— relatively low salaries,
— excessive fiscal measures,
— outdated and poor equipment of the work place,
— difficulties in the contacts with the leading scientific centers and in the availability of scientific literature,
— lack of perspectives of stable work and life, which is usually related to the general instability of the economic situation of a given country, accompanied, as a rule, by social and political instability.

When we speak of political factors we mean those that concern first of all the necessity of subordinating the research in certain domains (and especially in social sciences) to the requirements of the dominating ideology. Speaking more generally, different opinions and even "insubordination in thinking" may not always be tolerated and would in the extreme cases be prosecuted, as we can see on numerous examples from history.

When social causes are referred to we can quote low social status of science as compared to other spheres of social life, and consequently — low ranking of scientists in the social image of particular professions.

Then, there are individual psychological factors among which we can cite the incapacity of realization of own ambitions, the feeling of underestimation of the profession practiced by a given person within the circle of friends and acquaintances, being the derivative of the general atmo-

sphere in the country, and finally the low material status in comparison with other professional groups.

Finally, one should account for the cultural factors, which are of bigger importance only in some countries, the ones that we could describe as the countries with traditional culture, where there exist numerous restrictions dictated, for instance, by religion. These restrictions could, in particular, determine the place and role of women in the society and in family, as well as their behaviour in everyday life. The "escape" from such a country is the expression of a tendency towards broadening of the domain of freedom in personal life.

The present chapter will be devoted to consideration of the economic situation of just one minor part of Polish society — the highly skilled employees of the Research & Development (R&D) sphere and of the universities. In spite of the little absolute magnitude of this group within the society its significance for the country and the economy is beyond doubt. That is why it is by no means unimportant from the point of view of the developmental capacities of Poland what is the material situation of these people.

The financial and material situation of science is closely related to the economic situation of a given country. In a pure form this relation is direct and, if we exclude the correcting factors, it is of linear nature. The corrections are brought into this relation by, in particular, the policy of the state.

In highly developed countries the rates of growth of expenditures on science and of the improvement of its financial standing are quicker than the rate of economic growth. The increase of outlays into this sphere occurs usually in the situations of transitory slowdown of the economic growth, this being the consequence of the conviction that it is just research that can bring back the quick pace of economic growth.

In countries with lower level of development the science sector is treated either on a par with other spheres financed from the budget or, similarly as in the previous case, the outlays into science are considered to be the "locomotive of development". Poland belongs to these countries in which outlays into science always dragged behind the growth of the domestic product.

1.1. The economic situation of the research and development sphere

The economic reasons of the *brain flight* are the derivative of the systemic conditions established by the state for the R&D sphere and university education. The R&D sphere in Poland encompasses the following institutions:

— scientific units of Polish Academy of Sciences,
— research and development units, such as research institutes, research and development centers and the so called central laboratories,
— units providing service for science and technological development, such as libraries, scientific archives, scientific, technical and economic information centers, centers for technological progress etc.,
— the development units, located in various sectors of national economy.

Total employment in this whole sphere and in the university education amounts altogether to approximately 150 thousand persons and constitutes mere 1.4% of the total employment in the socialized sector.

Excepting the development units, which are not the subject of the present study, the scientists in proper sense constitute more than 43% of the employment number cited, that is — a bit more than 65 thousand persons.

The outlays into the R&D activities amounted in 1990 to 8,620.1 billion Polish zlotys, equivalent to 1.9% of the national income distributed. For the sake of comparison let us quote the outlays from the budget into the state enterprises — 15,406.4 billion zlotys, and the outlays into another sector of economy — finances, which amounted to 11,952.6 billion zlotys. One should add, of course, that these examples have a simply illustrative nature, for the revenues from the two sectors mentioned are, obviously, much higher than the expenditures into them. They are higher in the case of industry by more than the factor of ten and in case of finances — by the factor of almost two.

In the framework of expenditures for science and higher education the position "science" (research) received from the budget 421.9 billion zlotys, and " higher education" — 6,211.8 billion zlotys, corresponding, respectively, to 0.2% and 3.6% of total expenditures. Some other spheres of non-material nature participated in the expenditures from the budget in the following manner: culture and arts — 1.8%, education and upbringing (here — excluding university education) — 12.8%, health and social care — 19.0%, physical culture, sports, tourism and recreation — 3.3%.

The comparison of expenditures into science and higher education with expenditures into other kinds of sectors in 1990 shows in a clear way that the sector of our interest is underprivileged. It should be noticed that this sector ranked on more or less the same position as state administration in the importance ranking according to budget expenditures, but far away after health and social care as well as education and upbringing. Science alone was getting the least share of budgetary means among all the non-material spheres.

The plan for 1992 assumed 2% of total disbursements for science, which would constitute an improvement over the previous year, were it not for the general decrease of the expenditures from the state budget. The share of expenditures for university education was simultaneously significantly decreased — down to 2.2% of total expenditures from the state budget.

The shares of disbursements into science and higher education against the background of shares of other non-material spheres during the last 10 years — this period being of particular interestin the present report — are shown in Table 1.1.

Calculation of outlays per 1 employee in the sphere of our interest is extremely difficult because of incomparability of various categories involved. We could only cite the following example: if we admit, after official data, that Polish Academy of Sciences employs altogether some 14,200 persons then the overall sum of 88,261 million zlotys envisaged for the expenditures of this institution in the Budgetary Law of 1992 yields approximately 6 million per person per year. When analysing the Budgetary Law we can easily conclude that the same indicator in education and upbringing equals, approximately, 30 million zlotys, in culture and arts — 28 million zlotys and in state administration — 55 million zlotys.

As far as the tendencies of the recent years are concerned, they are presented in Table 1.2.

The data presented imply that the policy of the state with respect the R&D sphere in the second half of 1980s and at the beginning of 1990s was characterized by important fluctuations. This is illustrated, in particular, by the abrupt decrease of the outlays considered here from 2.2% of the national income distributed in 1988 to 1.2% in 1989. Likewise, the increase of this share in 1990 does not seem to be the reflection of a new stable tendency in the policy of the state with respect to science, nor does the planned nominal growth of the share in 1992.

One can hardly imagine a modern state conducting the long term

Table 1.1.

Current expenditures from the state budget into selected sectors of the non-material sphere in % of total disbursements (on the basis of current prices)

Sector	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Science	1.2	1.2	1.1	1.0	0.9	0.8	0.2	0.8	0.4	0.2	..	2.0
Education and upbringing	7.5	8.9	11.2	11.4	9.5	9.4	9.9	9.5	11.8	12.8	11.6	8.2
Higher education					2.1	2.1	2.2	2.4	2.8	3.6	..	2.2
Culture and arts*	1.1	1.2	1.8	1.8	1.7	1.6	1.8	1.9	2.2	1.8	1.0	0.7
Health and social care	8.6	9.9	11.6	11.4	11.6	12.2	12.9	13.0	13.6	19.0	21.6	19,0
Physical culture, sports, tourism and recreation	0.3	0.5	0.6	0.5	0.5	0.5	0.5	0.6	0.7	0.6	0.4	
State administration, justice, public prosecution and safety	4.0	4.8	5.8	6.0	6.3	6.4	6.6	6.4	6.7	7.9	7.8	6.5
Finances and social insurance	5.9	14.4	12.9	11.5	12.2	10.9	5.4	5.5	12.3	16.6	23.4	20.3**

* For the years 1983–1985 the shares encompass only the subsidies for the Culture Development Fund and the expenditures on state radio and television.

** Only social insurance.

Sources: Own calculations on the basis of *Roczniki Statystyczne (Statistical Yearbooks)*, GUS, Warszawa, various years, *Mały Rocznik Statystyczny 1992 (Small Statistical Yearbook 1992)*, GUS, Warszawa 1992, Budgetary Law for 1992 of June 5th, 1992, *Dziennik Ustaw RP*, no. 50, Warszawa, June 29th 1992.

development policies that could tolerate such a situation. A certain justification in the Polish case is provided by the unstable conditions of the systemic transformation, during which the government is not controlling the fundamental financial relations in the economy.

Analogous conclusions can be drawn on the basis of analysis of the dynamics of investment outlays. Although these outlays in the sector in question were in 1990 still higher than in the middle of 1980s, but their significant drop in comparison with the previous year indicates the lack of consciousness on the side of the authorities as to the actual state of the fixed assets of the universities and research institutes.

One should perhaps add here that employment, which has been systematically decreasing since 1988 cannot be treated as as a reason and a justifying factor for the constantly decreasing outlays. There is namely, in reality, an inverse relationship — it is the decrease of employment that results from the diminishing (even if just in relative terms) shares of means devoted to science, research and development. This situation finds its reflection in all the spheres of activity of the institutions considered.

Table 1.2.

The dynamics of some quantities characterizing the Research & Development potential

Items	1985	1986	1987	1988	1989	1990
The % shares of outlays into R&D in the national income distributed	1.7	1.7	2.1	2.2	1.2	1.9
Investment outlays in the institutes of Polish Academy of Sciences and in other R&D units (in current prices 1984) — 1985=100	100.0	122.4	150.7	150.7	122.4	104.5
Employment in the institutes of Polish Academy of Sciences and in other R&D units, 1985=100	100.0	101.5	103.5	97.7	89.8	81.1

Sources: *Nauka polska w liczbach 1985–1990*, GUS, Warszawa 1992.

1.2. Financial situation of scientists

There is a common opinion in Poland that the material situation of scientific institutions and their employees is bad. The persons involved describe this situation as dramatic.

In spite of the thus evident bad financial situation of the majority of persons employed in scientific institutions, including those employed in service for science, it is not easy to fully statistically represent the phenomenon. Information which is largely aggregated fuzzifies here the true picture of the situation, since we are dealing with the organizational units of very differentiated nature.

Thus, for instance, the set considered contains the research and development units belonging to the Ministry of National Education, where in 1990 the average salaries of scientific employees were almost two times higher than the national average, and the units of the State Agency for Nuclear Research, where the average salary is only slightly higher than the national average. All these institutions considered are also differentiated internally, and the analogous positions in them differ among themselves yet more. And thus, the group of research assistants and senior research assistants, located at the bottom of the hierarchy of scientific positions, earned in 1990 in the Nuclear Agency mentioned before the equivalent of 87.7% of the national average, and in the units belonging to the Ministry of Culture and Arts — a bit over 100% of the national average, that is

— only 11% less than the adjoint professors in research and development institutes of the Ministry of Spatial Economy and Construction.

Within the group of full professors (excepting those working in the universities) it is the ones who worked in the units belonging to the Ministry of National Education that had the highest salaries, higher by 37.4% than the salaries of professors employed in the Nuclear Agency, who earned the least among professors. A similar difference (of 37.7%) existed between the associate professors working in the units subject to the Ministry of Education and those working in the units belonging to the Ministry of Agriculture and Food Economy, the two representing the extremes in this group of employees. The greatest differences were observed in the group of adjoint professors — the salary range between the best earning adjoint professors employed (again!) in units subject to the Ministry of Education and the least earning ones employed in units belonging to the Ministry of Spatial Economy and Construction amounting to 42.4%. A lesser difference exists between the groups of research assistants within the above two institution classes, namely 36.7%. The financial situation of persons employed in science in the second half of 1980s and at the beginning of 1990s, compared with the national averages, is illustrated in Table 1.3, given further on.

Table 1.3.

Average monthly salaries of scientists employed in the R&D sphere in % of the national averages

Positions	1985	1988	1989	1990
Full professors	179.4	242.7	198.0	226.0
Associate professors	158.2	195.1	155.2	173.3
Adjoint professors	128.3	155.0	124.2	131.2
Research assistants	90.5	111.6	89.1	94.1

Sources: Own calculations based on: *Nauka polska w liczbach 1985–1990*, GUS, Warszawa 1992, and on *Rocznik Statystyczny (Statistical Yearbook)*, various annual editions, GUS, Warszawa.

Information contained in Table 1.3. concerns only a group of a dozen thousand persons (in 1990 — exactly 15,170). Within this group there were in 1990 exactly 1196 full professors, i.e. 7.9% of the total. The shares of other positions were: 11.5% for associate professors, 52.7% for ad-

joint professors, and 27.4% for research assistants and senior research assistants. Thus, as can easily be seen, only the employees belonging to the last of the groups mentioned (composed mainly of young scientists) earned salaries below or close to the national average (excepting 1988, when their salaries exceeded the national average). The salaries of all the other groups, and especially of full professors and associate professors were significantly higher than the national average. In some cases they were higher than the national average by the factor of almost three. As far as the dynamics of salaries is concerned one could observe in the second half of 1980s a very characteristic downward trend in relation to the national average. In 1990 there was generally a relative improvement of salaries, although with some exceptions. These exceptions are constituted by associate professors in the units subordinated to the Ministry of Transport and Maritime Economy, adjoint professors in the units belonging to the Ministry of Industry and Trade as well as Ministry of Spatial Economy and Construction, and also assistants in the institutes subordinated to the Ministry of Industry and Trade and to the State Agency of Nuclear Research. These exceptions may be the symptoms of differentiation of the policies with respect to various institutions, but not necessarily so. The observation quoted is namely a singular one and the circumstances observed may result from quite a random coincidence, considering the instability and lack of a consequently directed and conducted scientific policy of the state.

The situation in higher education and, generally, in the "education and upbringing" sector presents itself in a much worse manner. Table 1.4., given in the preceding page, shows in detail the dynamics of the levels of salaries in these sectors during the 1980s and at the beginning of 1990s, as well as for 1960 and for the selected years of the decade of 1970s.

During 1960s and 1970s, in spite of various fluctuations, science was ensured quite a decent position in the state economy. Deviations upwards from the average by 18.3% in 1960, by 21.6% in 1970 and by 13.3% in 1978 constitute the evidence. In 1980, in spite of the economic crisis the salaries were still higher than the national average, though more due to the internal petrified mechanisms determining salaries than to a conscious policy. The situation at the beginning of 1980s fully reflects the continuing crisis, including the lowest point of 1982. An effort was made in the period 1984–1988 of assigning a higher significance to science, so that during the

first three years of the second half of 1980s the salaries in science were relatively higher.

In the subsequent years the fluctuations reappear and there is a slight improvement of the situation which is, however, of little importance in view of emergence of the competitive market of highly skilled labour.

The last column of Table 1.4. does not require any comment. Irrespective of other causes, in the light of these data the downfall of the prestige of the teacher's profession — including university teachers — should not come as a surprise. The negative selection of people for this profession, the withdrawals of the best teachers and of the research and teaching employees (in case of universities) are a simple consequence of salaries which are lower by some 20% than the national average.

The situation is further disproved by the fact that the incomes of this group are not "warranted" — they are to a large extent (of even up to 14%) earned in overtime work. The share of such earnings is much higher than in other professions. In comparison with the national average the share of overtime earnings is higher by more than half.

The financial situation of highly skilled persons has been and still is (with exception of persons employed in private firms, of course) very difficult in Poland. According to the study performed by GUS on the random sample of employees working in various institutions the share of persons with university education earning in May 1990 up to 1 million zlotys was 51.8% , while the national average of all the salaries earned was 906.8 thousand zlotys.

In the sample obtained the earnings of 1.4% of persons were lower than 400 thousand zlotys, of 3.5% — between 400 and 500 thousand zlotys, of 11.5% — between 500 and 700 thousand zlotys, of 17.5% — between 700 and 850 thousand zlotys, and of 17.9% — between 850 and 1000 thousand zlotys. Then, there were 15.9% of persons earning more than 1450 thousand zlotys.

The level of university education and the quite frequent high skills of persons from the group here considered incline to make comparisons of own incomes with the ones earned by persons of similar qualifications. And thus, a person teaching at the university, who would earn in the first quarter of 1992 2,615.1 thousand zlotys before tax on the average (the US dollar exchange rate in the middle of 1992 being at a bit less than 14,000 zlotys) is certainly comparing own salary to that of a medical doctor, whose salary has grown already to 3,462 thousand zlotys, and to those of the officers of state administration, where the average salary is 3,046.8

Table 1.4.

Average monthly salaries in "science and technological development" and in "education and upbringing"

Year	National average in zlotys	Science and technological development (STD) in zlotys	Education and upbringing (E&U) in zlotys	Difference with respect to national average in %	
				STD	E&U
1960[a)]	1560	1846	1376	+18.3	−11.8
1970	2235	2718	1933	+21.6	−13.5
1972	2509	3174	2321	+26.5	−7.5
1974	3185	3720	2762	+16.8	−13.3
1975	3913	4198	3052	+7.3	−22.0
1976	4281	4756[b)]	3309	+11.1	−22.7
1978	4887	5539	3885	+13.3	−20.5
1980	6040	6362	4865	+5.3	−19.5
1981	7689	7603	6085	−1.1	−20.9
1982	11575	10312	9306	−10.9	−19.6
1983	14475	13693	11454	−5.4	−20.9
1984	16838	17106	14155	+1.6	−15.9
1985	20005	21697	16577	+8.5	−17.1
1986	24095	29253	19021	+21.4	−21.1
1987	29184	35352	23054	+21.1	−21.0
1988	53090	65093	37851	+22.6	−28.7
1989	206800	207200	189900	+1.9	−8.2
1990	1029600	1070000	1057700	+3.9	+2.7
1991	1770000	2104700	1590400	+18.9	−10.1
1992[c)]	2456000	2856400	1938300	+16.3	−21.1

[a)] Not accounting for the bonuses from the company's bonus fund.

[b)] Estimated value.

[c)] Before tax (value for the Ist quarter of the year).

Note: The sector of "science and technological development" refers to R&D units (institutes of Polish Academy of Sciences and of particular ministries) and to units providing service for science and technological development (centers of scientific, technical and economic information, scientific libraries and archives, scientific associations and other scientific service units). The sector of "education and upbringing" encompasses here also universities.

Sources: Own choice and calculation based on *Statistical Yearbooks* and *Small Statistical Yearbooks*, GUS, Warszawa, various annual editions.

thousand zlotys, or finally to the earnings of persons employed in the financial and insurance companies, whose average is at 3,733.9 thousand zlotys. We could mention at the end of this paragraph that, for instance, salaries in foreign trade are at 4,370.3 thousand zlotys on the average, and in air transport — at 3,978.3 thousand zlotys.

One of the consequences of the bad financial situation of the majority of scientists is the search for additional jobs, which quite often have nothing to do with their scientific interests. These people take sometimes half-time jobs as additional ones and presently shift frequently among various employers, changing their skills in order to be able to acquire higher incomes.

A part of those who work in science and higher education (approximately 20% in 1991) take advantage of the foreign scholarships. Irrespective of scientific advantages this allowed for certain material benefits accruing from the scholarship.

1.3. The environment and equipment of the work place

The value of the fixed assets which were at the disposal of the sectors of "science and technological development" and "education and upbringing" was estimated altogether at 83,308.3 billion zlotys in December 1990. In relation to the global value of fixed assets existing in the whole of national economy these two sectors disposed, respectively, of 0.4% and 2.0% of the assets. In comparison with the middle of 1980s this share increased somewhat. During the period 1986–1990 science was obtaining 23 buildings per annum on the average while education was obtaining 546 buildings. The comparison with such other sector as culture is certainly advantageous for science. The dynamics of investment outlays is illustrated in Table 1.5.

These data clearly show the neglect or outward disregard of the material sphere of science, while the situation of education seems to be somewhat better. The phenomena mentioned are also confirmed by the data concerning the degree of wear of the elements of fixed assets. This degree was in 1989 in science estimated at 43.7% and it increased till the end of 1990 in a frightening way to attain 53.9%. The respective increase in education was from 28.4% to 34.1%. The average degree of wear of the fixed assets in the country is at 42.8%, but it is the highest just in science. Education, on the other hand, belongs to the sectors where the degree of wear is one of the lowest.

Table 1.5.

The year-to-year dynamics of investment outlays in science and in education. Previous year = 100.

Sector	1986	1987	1988	1989	1990
Poland as a whole	105.1	104.2	105.4	97.6	89.9
Science and technological development	122.8	123.5	98.8	81.1	85.6
Education and upbringing	107.8	104.8	107.5	93.2	102.9

Source: *Statistical Yearbook 1991*, GUS, Warszawa 1991.

The fixed assets of the highest total value are concentrated in the R&D units. The superiority with respect to the institutes of Polish Academy of Sciences is of more than factor of 7.5. The units providing service for science and technological development dispose of a much smaller value of fixed assets. The increase in the latter over the year 1990 was, however, quite significant — by 46.9%, while the increase for the R&D sphere (excepting universities) was at mere11.4%. Investments made until presently brought a limited improvement in the premises, and only in some institutions. The difficulties concerning premises constitute one of the main problems in organization of work in a large portion of scientific institutions.

We should perhaps cite here the statement of Professor Wojciech J. Stec (1991) from the Laboratory of Bioorganic Chemistry of the Center for Molecular and Macromolecular Studies, belonging to Polish Academy of Sciences:

> *The greatest obstacle in the development of production activity are difficulties with the premises, in which chemists and biologists have (now) to work together. The atmosphere of chemical work "poisons" the bacterial cultures. It is therefore not possible to plan the activities related to cell cultures, necessary for realization of programs in the area of protein bioengineering with the rec DNA method. The design work on the construction of the biotechnological pavillion, undertaken in 1988, were slowed down due to financial limitations.*

There is a common conviction that the scientific institutions are insufficiently equipped with research and didactic facilities. The comparison of a vast majority of our institutions with the analogous ones in the West is

especially disadvantageous for us. There are only few positive examples with that respect in Poland. Professor Sylwester Porowski from the Laboratory of High Pressures of the Polish Academy of Sciences, UNIPRESS, states in the publication quoted previously:

> *The material basis of the Laboratory is relatively good. (...) Besides the typical measuring equipment, of the average European level, the Laboratory has numerous high pressure devices which are unique on the global scale.*

The highest share of the value of research and didactic equipment among all the sectors of economy is observed within the universities — 31.7%, then in the institutions working for the industry — 31.2%, for health care — 13.3%, for construction — 11.2% and agriculture — 10.5%. The research and development units dispose of 9.5% of total value of research and didactic equipment, and within this share — Polish Academy of Sciences has 7.4%. These magnitudes should not be treated as the reflection of the true scientific and research potential of given institutions. The value shares quoted should namely be related to the unit costs of devices owned. The most expensive devices are the ones which serve very narrowly specialized purposes, and they are most often used by the small teams of researchers.

The task of the scientific policy is to determine the domains which should be developed in the first place, and which should therefore be equipped in the facilities corresponding to European or world standards.

Between the middle of 1980s and 1989 the share of the value of the equipment owned by the universities decreased from 58.6% in 1986 to 39.6 in 1989, while it has been growing, as a rule, in other sectors. This could mean that efforts have been undertaken to compensate for the previous investment shortages in the institutions belonging to particular ministries, or that the policy was started of investing in these units which — in the opinion of decision makers — were to bring the "practical effects" sooner.

In the breakdown according to scientific disciplines it is the technical sciences that have the greatest share of value of the equipment. This value, though, has been decreasing from 72.9% in 1985 to 47.7% in 1990. The second place is occupied by medical sciences, whose share, on the other hand, increased from 9.9% in 1989 to 29.4% in 1990. Natural sciences went through ups and downs with that respect in the second half of 1980s and finally, with the share of 19.1% occupy the third position. Economic sciences, whose functioning is related to a lesser degree to the availability

of the research equipment, had the share of value of this equipment equal 0.2%.

The value of investments in the equipment per 1 scientist was in 1990 the highest in the research and development centers — 1,538.9 million zlotys, and in medicine — 1,874.4 million zlotys. The lowest values of this indicators were observed in social sciences — 34.5 million zlotys, and in the universities — 145.4 million zlotys.

The quality of the equipment owned by the scientific and research institutions, though, leaves a lot to be desired.

1.4. Accessibility of knowledge and information

Another example of a bad economic situation of the R&D sphere andthe universities is provided by the limited possibility of taking advantage of the modern achievements of scientific thought and, generally, of information necessary in research. In spite of the assistance of Western governments and various scientific institutions the situation in this domain is getting constantly worse due to lack of means for foreign visits and for systematic purchases of scientific literature.

Broadening of knowledge and gathering of information is also being done through the longer term stays in foreign centers and through participation in international conferences. Polish institutions, though, are not capable of financing the participation of a higher number of their employees in the international meetings or of making choices as to the foreign centers or scientific events. Polish scientists are as a rule making use of foreign means and are entirely dependent upon the invitations obtained. Thus, there is no possibility of shaping systematically a definite profile of a given scientific unit.

Table 1.6.

Foreign scientific scholarships.

Institutions	1980	1985	1990	1991
Universities	4759	9621	13877	10829
Polish Academy of Sciences	436	240	314	1705

Source: *Small Statistical Yearbook 1992*, GUS, Warszawa 1992

The intensification of interest from the side of the West in the countries of this part of Europe is a transitory phenomenon, as one is able of noticing already now, and the financial assistance will be getting increasingly limited.

We do not dispose of data concerning the scientific literature alone, but we would like to recall that the number of new titles published in Poland is very small, and that this concerns also the scientific literature.

Thus, in 1987, 10416 titles were published in Poland, while in the same period in France and in Japan the numbers of titles published were more four times greater, in Spain — three and a half times greater, and in Germany — even six times greater. The numbers of titles published in Italy, Netherlands and Denmark were also significantly higher. Similar numbers of titles as in Poland were published in Czecho-Slovakia and in Yugoslavia, and lower numbers in, for instance, Austria, Belgium, Bulgaria, Norway, Portugal or in Hungary, but all these countries have much smaller populations than Poland.

1.5. Some international comparisons

The statistical material available does not allow making more precise comparisons of the current situation in Polish science with that in other countries. On the basis of existing data one can present, though, for the second half of 1980s, some interesting and telling information.

The indicators concerning the education level of the society are alarming. Only approximately 8% of population of 25 and more years of age have more than secondary education (data as of 1988), while the value of the same indicator at the beginning or in the middle of 1980s was in Finland at some 14%, in Sweden — at almost 15.5%, and in Canada and United States at approximately 30%. The university education indicator that is similar in value to the one for Poland is observed in Czecho-Slovakia, Greece, Spain and Hungary.

It is not less alarming that the level of commonness of university education is lower than elsewhere. Thus, for instance, the number of university students expressed as the share of total population in the given age group was in Poland in 1987 at 17.8%, while in Scandinavian countries, in Benelux countries, in France, Spain and Germany it attained more than 30%. In Canada and United States this share approached even 60%,. Such countries as Greece, and also Bulgaria, Ireland and the previous Soviet Union had higher university students shares than Poland. The shares

were somewhat lower in Czecho-Slovakia and in Hungary. The number of university students per 10 thousand inhabitants significantly exceeded in the highly developed countries 200 persons. In Poland this indicator amounted to only 122 persons. In the countries of Central and Eastern Europe the values of this indicator were as follows: in Bulgaria — 152 persons, in Czecho-Slovakia — 110 persons, in previous Yugoslavia — 149 persons, in Eastern Germany — 264 persons, in previous Soviet Union — 179. The values considered were clearly lower in Hungary — 94 persons, and in Rumania — 69 persons.

The structure of teaching in the higher education system is in Poland — roughly speaking — closer to the structure encountered in Western countries than in the other countries of Central and Eastern Europe, where there was "domination" of technical sciences. In Western Europe, on the other hand, the shares of exact and natural sciences are significant (see Table 1.7.), since these two domains are decisive for the possibilities of development of modern technologies. A relatively high share of agricultural sciences in Poland, for instance in comparison with Denmark, is inversely proportional to the results of these agricultures. The studies of humanistic disciplines are much less developed in our country than in the Western countries.

Table 1.7.

Students according to directions of the study in selected countries at the beginning of the second half of 1980s in % of total numbers of students.

Country	Study directions					
	Technical	Agricultural	Law and social sciences	Humanistic sciences	Exact and natural sciences	Medical sciences
Poland[a)]	17.8	7.1	21.6	8.8	4.5	13.1
Denmark	16.0	2.4	24.3	14.2	7.2	14.4
Western Germany	17.6	2.9	28.0	12.7	11.6	14.0
Sweden	19.3	1.5	29.1	14.9	9.4	14.1
Bulgaria[a)]	35.8	4.8	18.0	7.6	4.3	8.8
Czecho-Slovakia	42.1	9.2	15.9	1.2	3.1	7.8
Eastern Germany[a)]	32.3	5.6	16.3	2.1	3.1	13.5
Hungary[a)]	17.3	5.7	16.9	2.5	2.4	9.0

[a)] Together with evening and correspondence (extramural) courses.
Source: *Rocznik Statystyki Międzynarodowej 1991, (The Yearbook of International Statistics 1991)*, GUS, Warszawa 1991.

The financial means devoted in Poland to education are lower than in other countries. They constituted in 1987 only 4.4% of the gross na-

tional income, while in Scandinavian countries — from 6 to 8%, in the countries of Benelux — 6 to 7%, in Austria, France and Hungary — approximately 6%, in Czecho-Slovakia, United Kingdom and Switzerland — approximately 5%. The share of expenditures into education in Germany is comparable to the one in Poland, and in Spain it is lower, for it attains mere 3.2%. One should remember though, that in the case of Germany — and even of Spain — the absolute level of these means is completely different than in Poland. It is also alarming that the expenditures considered are decreasing in Poland (by 0.4% in 1985), while in numerous countries they have been growing or at least remaining on the same level.

In many European and non-European countries the research and development activities are financed to a greater degree from the special funds and from the funds of production enterprises than from the state budget. The first kind of funds dominate in such countries as Japan, Switzerland and Hungary. In Austria and Denmark there is a balance between the two kinds of funds, while in France and in Italy the state funds are dominating in financing of science.

The numbers of persons considered as scientific and technical staff, including scientists and engineers, are quite differentiated. Thus, for instance, in Denmark, in the second half of 1980s there were 80 persons in this group per 1000 inhabitants, and the numbers were similar in Italy. In Eastern Germany, Bulgaria, Spain and Western Germany the value of this indicator was 100 to 150. More than 200 persons per 1000 inhabitants were observed in, for instance, Netherlands, Sweden and Finland (as many as 375 persons in the latter country). Poland ranks between these two groups of countries with the value of the indicator equal 168.

The ratio of the number of persons directly involved in scientific work to the number of the scientific and technical staff are also differentiated. This ratio is in Poland not too high — just about 2%. In Bulgaria, where respective statistics do not account for the higher education sector, the value of the ratio is approximately 6%, while in Spain, in conditions comparable to the Polish ones — only 0.5%. The ratio, accounting for the auxiliary scientific personnel, was much higher in Eastern Germany — 11.5%, and Denmark — more than 5%, but lower in Finland — 1.4% and in Sweden — some 2%.

This short survey of the economic situation of Polish science and the university education system explains certainly at least a part of the phenomenon of the *brain flight* to foreign countries and toother occupations in Poland.

2. RESEARCH ASSUMPTIONS AND FUNDAMENTAL RESULTS OF THE STUDY

2.1. The empirical study of the *brain flight*, definitional questions

The problems of the *brain drain* have been promoted by the politicians and journalists taking up the questions of dependencies between the countries of the "First" and the "Third" world as seen from the point of view of relations of exploitation and sweating existing between them. A particular intensity of this type of publications occurred in the world press at the turn of 1970s. As it happens very often in this type of pronouncements they were mainly oriented at definite short term political effects in terms of demands and claims. The publications mentioned were very rarely based upon any kind of numbers, and even if some numbers were quoted, their origin and reliability were unknown. That is why all these publications should be approached with great care.

During the last two years the post-communist countries found their way to the papers and articles devoted to the subject of the *brain drain*. The attempts aiming at identification of this problem domain are based, in principle, on the governmental statistics or on the estimates founded upon the same statistics. The studies of the matter in the proper sense of the word have not yet been undertaken (Brain Drain Issues 1991, Rhode 1991).

Scientific studies of the *brain drain* or, more precisely, of the *brain flight*, are relatively rare. This is due to the fact, itseems, that this direction of research does not create a broader heuristic perspective neither in the sphere of theory nor in methodology. Then, there is also a dispersion of the information sources, not comparable with dispersion of sources for

other, traditional research domains in social sciences. In order to illustrate these difficulties it is sufficient to quote the case of identification of causes of foreign migrations of scientists which would require knowledge of the numbers of persons migrating to various countries, then — reaching of the home institutions of the migrating scientists, and only after this has been done — one would be able to start the procedure of selection of the respondents.

It can be assumed that the difficulties mentioned above are the most important factors causing that the studies of the *brain flight* carried out to date are characterized by an undefined level of representativeness. In order to justify this evaluation we have put together Table 2.1, containing the fundamental characteristics of the research reports available in Poland, concerning the subject matter considered here. It can be concluded from this table that the majority of the scientists involved referred to so small samples that they can in no way be treated as representative ones, neither for the professional structure nor for the directions of migrations.

Table 2.1.

Studies on the *brain drain* according to magnitudes and kinds of samples, countries, dates of studies, authors and directions of migrations.

Country Author	Number of respondents	Directions of migrations to the centres	 among the countries of the centres	Groups studied
India, Das 1978	170	Yes	No	Scholarship
U.S.A., Wondenberg, Mc. Kee 1980	74	No	Yes	Economists
Philippines, Joyce, Hunt 1982	75	Yes	No	Nurses
South America, Americo 1983	other statistics	Yes	No	Physicians Engineers
United Kingdom, Collins 1988	578	No	Yes	Engineers, Scientists

Let us look now how the phenomenon of the *brain flight* is being defined in the scientific analyses of these problems.

Note first that the journalistic attitudes are sometimes surfacing also in the scientific domain in the form of value statements introduced into the construction of scientific definitions. Let us quote, as an instance, the

following formulation: *the "brain drain" consists in appearance of losses inthe intellectual potential borne by the developing countries due to the fact that the students learning abroad do not return to the country of their origin after they have finished their studies* (Das, 1978). Such a definition was constructed for purposes of the study of the *brain drain* from India.

A similar manner of defining the phenomena described can be encountered in the work of some Latin American analysts. And thus, R.Americo states that the *brain drain* is a reverse technological transfer, consisting in the weakening of the technological potential of the developing countries due to migration of highly specialized personnel (Americo, 1983).

It should be admitted, though, that majority of the research reports referred to further on contain evaluations in their conclusions and not in the definitions of the subject of study.

Thus, for instance, B.Rhode states that although the notion of the *brain flight* has some normative undertones, it concerns first of all the comprehensive market relations between various countries. We are dealing here, in particular, with the competition of the economies in acquiring skilled labour force. This competition is closely connected with the readiness to change the place of residence on the side of the skilled employees (Rhode, 1991, pp. 27–28).

Most scientists comprise in the notion of the *brain flight* the phenomena consisting in a relatively long time of absence in the country of origin or permanent outmigration of persons with a relatively high education level. And so, one of Indian scientists studying the *brain flight* question, included in his analysis the observation of migration of skilled labour force from India and other less developed countries (B.N.Ghosh, 1979, p.280). The notion of skilled labour force is usually understood so as to encompass the graduates of universities and the persons representing special kinds of demanded skills, whose acquisition is not necessarily connected with scientific or professional titles, like e.g. in the case of nurses (Joyce, Hunt, 1982).

We omit in the present report the ideologically loaded term of *brain drain*, replacing it by the more adequate notion of *brain flight* or simply — migration. It may also be added that the notion of the *brain drain* would be justified if it were possible to demonstrate that some country is conducting with respect to another one a policy aiming at absorbing the staff with university education.

2.2. The causes of the *brain flight*

The reasons which make persons with relatively high skills leave their countries of origin can be classified into two groups. The first of them would contain those which concern individual motivations, while the second one — the systemic factors, external with respect to the individuals. The systemic factors are connected with definite features of institutions and social as well as economic structures in the countries of origin of the migrants with high professional status. The examples of such factors are: the nature of the labour market, the relations among the wages of various professional groups, the outlays into research etc.

Let us now look at the systemic causes of the *brain flight*. According to B.N.Ghosh the the most important cause of migration of the highly skilled specialists from India is the very big difference of incomes that can be gained in India and in other countries. Another important cause is the unprecedented educational expansion of the inhabitants of India and the lack of capacity of absorbing such high numbers of educated personnel by the economy of this country. Thus, the subsequent factor motivating to outmigration is the non-satisfied demand for educated employees abroad and the surplus of such potential employees in India (Ghosh, 1979).

Another analysts, who studied the sample of 500 Indian scholarship holders after they had returned to India, considered the impossibility of finding an adequate job in India as the most important factor motivating to migration (Das, 1978).

There were specific reasons for foreign migrations of the research employees in the communist countries. They were first of all related to political issues. It should be remembered that various failed attempts of anti-communist revolts were accompanied by intensified waves of migration from Hungary, Czecho-Slovakia, Poland and German Democratic Republic. On the other hand, though, relative isolation of the communist countries and significant difficulties in scientific contacts were quite effective in reducing the number of potential migrants (Rhode, 1991). A special situation existed in social sciences, where such "scientific disciplines" appeared as, for instance, "scientific communism", which caused that quite a share of the scientific potential was engaged in the activities having no relation whatsoever to the world science. This local nature of scientific interests made it difficult or impossible for a part of the scientific staff to find employment outside of own country.

A specific setting of the systemic factors motivating to outmigration existed also in the scientific communities of the previous Soviet Union.

Although the possibilities of having foreign contacts improved there very much along with the progress of *perestroika*, and the freedom of choice of research domains and methodologies significantly increased, all of this is accompanied by very bad socio-economic conditions, motivating to migration from the country (Cave, 1991). Similar conclusions can be drawn from the study performed by another analyst, who states that *perestroika* dealt a blow to Soviet science, this blow consisting in breaking of isolation and in permanent foreign migrations (Berry, 1991).

The *brain flight* has also been observed in the United Kingdom. Scientists from this country migrate to USA because of the incapacity of the government to conduct an effective scientific policy, which would ensure a stable inflow of means to scientific institutions (Collins, 1988).

Thus, we have outlined the systemic causes for the *brain flight*. But what are the systemic mechanisms of attraction? It is obvious that one of the most important ones is the readiness on the side of a given country to admit the research and scientific migrants. The United States, for instance, do not limit in principle this kind of migration and no greater restrictions with that respect are envisaged for the future. Acquisition of new scientific staff brings namely important advantages to the "importing" countries. The calculations performed at UNCTAD suggest that in the period of 1960–1975 one skilled migrant was bringing the American economy some 180 thousand US dollars on the average (Teplan, 1991). Besides that we can point out certain specific features of the labour market in the USA causing that scientists coming to this country encounter a relatively lower competition from the side of graduates of the American universities, for the latter prefer to take up the better paid jobs in industry and are not too willing to get the relatively less paid positions in the universities. This is accompanied by the massive retirement of the scientific employees who started their careers in the period of rapid growth of the science sector in the United States in 1960s. These phenomena put together contribute to appearance of a sort of staff vacuum which is being and will yet be filled with important participation of people coming from abroad, and especially from Far East and Latin America. Central and Eastern Europe is treated as an additional source of inflow of scientific personnel (Teplan, 1991).

What are, then, the individual motivations of the intellectuals to migrate? Indian sociologist M.S.Das discovered on the basis of questionnaires filled out by 170 scholarship holders who had returned to India that the decision to migrate depends upon eleven factors. These factors

were, in particular: scientific discipline represented, job opportunities in India, age at the instance of leaving, number of children, marital status, income, aspirations, time which elapsed between graduating abroad and the return to the home country, time spent on looking for a job and the way of acquiring one as well as socio-economic status. Resulting from quite detailed analyses was the statement of the author quoted that the factor with the strongest influence was the opportunity of finding a job in India (Das, 1978). On the other hand, though, according to another Indian scientist the most important factor influencing migrations of specialists is constituted by financial motivations (Ghosh, 1979).

While migrations from poor countries to the rich ones are mainly explained with the discrepancy of salaries, in the case of migrations among the developed countries the main roles are played by other causes. And thus, the analysis of a group of American economists who migrated to Canada suggests that the most important factors include: scientific reputation of a given institution and the possibilities of conducting research in accordance with own interests (Wondenberg, McKee, 1980). P.M.Collins did analyse, in turn, the causes of migrations of engineers and scientists (active in biochemistry, chemistry, earth sciences and electronics) from the United Kingdom to the United States. On the basis of questionnaires, filled out by 578 persons this author established that the most important motivations of migration included facility in the conduct of research resulting from the availability of a better equipment, lesser barriers on the way to scientific career, salaries and the possibility of gaining broader scientific experiences (Collins, 1988).

It should generally be stated, though, that the analyses here referred to, taking up the subject of causes of migrations, do only in a moderate degree contribute to the development of knowledge on the *brain flight*.

This fact has several reasons. One of the most important ones is the unknown range of representativeness of the samples used in the studies outlined, which is caused largely by the impossibility of reaching the actual numbers of migrants. besides this, small numbers of individuals in the samples — see Table 2.1 — makes the capacity of generalization of conclusions when a bigger number of variables is allowed for abruptly decrease. Irrespective of the above one should point out the triviality of the discovered reasons of migrations. Still, we can summarize the considerations already presented by saying that the most important reasons of migrations include: the conditions on the labour market, the political

situation, the income perspectives and the opportunities of professional development.

2.3. Directions of migration of highly skilled staff and evaluation of relative losses caused by the *brain flight*

The majority of the phenomena described here can be explained by referring to the "center–periphery" theory. The countries of the developed center attract the highly skilled personnel from the less developed peripheral countries. What countries can be treated as belonging to the center? It is admitted that these countries are Canada, USA and Great Britain (Americo, 1983), with the greatest number of migrants directing themselves to the United States.

Thus, R.Americo studied the directions of migration of surgeons and dentists as well as engineers. It turned out that 80% of migrants from South America chose USA as their destiny, while the United Kingdom constitutes the goal of migrants from all the other parts of the Third World (Americo, 1983).

It should be noted, though, that not all the studies confirm the exceptionless nature of migrations from the peripheries to the center. There occurs, namely, that migrations in the reverse direction take place, caused by reasons similar to those that define the main direction of the international mobility of the highly skilled personnel. Thus, we can quote here migration of economists from the United States to Canada, mentioned before. It must be remembered, though, that the manner of realization of the studies referred to, and in particular the question of their representativeness makes it impossible to state whether we are dealing with a relatively steady divergence from the dominating tendency or only an insignificant incidence.

Assuming that United Kingdom is a member of the center in terms of the theory quoted, we must note yet another peculiarity in the phenomena here considered. It turns out namely that in the population of persons born in United Kingdom and granted doctoral degree in this country 9% per annum migrate to other countries and only 2/5 of this number is being replaced by the inflow of staff from abroad (Collins, 1988).

The exceptions mentioned before suggest that the statement stipulating the flow of personnel from the periphery to the center does not have a universal application under the adopted definition of the center. It describes, though, the dominating direction of migrations. The question

discussed in this manner would vanish, of course, were we to assume that the center of the developed world is made up by the United States alone.

One must note that none of the research reports cited mentions Japan, although this country is by all means a member of the world economic center. The cause, perhaps, lies in the enormous cultural distance from Japan, amplified by the reluctance to employment of foreign specialists. This seems to indicate yet another limitation to the universality of the flow of skilled personnel from the periphery to the center, since the countries of the center only then do attract larger numbers of foreign specialists when the following conditions are fulfilled: labour market is characterized by high accessibility, there is low intensity of xenophobia, there is cultural openness connected with low degree of rigour with respect to other lifestyles, and finally the cultural patterns are attractive on world or continental scale.

How is the phenomenon of the *brain flight* evaluated, finally? Although negative opinions of this phenomenon are the most frequent, the problem is far from unambiguous. And so, for instance, P.M.Collins states that most of the British members of the Royal Society work in the USA, which means that the scientific potential of United Kingdom is severely handicapped (Collins, 1988). On the other hand, though, some scientists studying these problems indicate that the losses of the developing countries resulting from the *brain flight* are not as high as it might seem at a first glance. This results from the fact that the countries in question — like e.g. India — are not capable of employing all the specialists who are their citizens according with the skills of these persons (Das, 1978).

In the light of these statements the possibility of foreign migration of the university graduates from the developing countries may be considered as a factor advantageous for political stabilization, countering political radicalization and rebellious attitudes of the middle classes.

The systemic transformations which take place in the countries of Eastern Europe caused, in particular, relative opening up of these countries and abolition of barriers for foreign visits. Since the conditions of "work and pay" of the scientific employees in these countries were incomparably worse than in the post-industrial ones, the phenomenon of the *brain drain* became a problem also in the post-communist Europe.

One should note that this problem was remarked quite soon by the international scientific institutions, which included it in their scientific programs.

And so, during the conference organized by the European Bureau for

Science and Technology of UNESCO in November 1991 in Venice the projects of research on the *brain drain* in several countries of Eastern Europe were presented and the state of knowledge of the subject was discussed.

Alas, according to B.Rhode, the current state of the statistical material does not make it possible to gain exhaustive knowledge on the migrations of scientists from the post-communist countries (Rhode, 1991, p.39).

The calculations performed to date have been based upon the initial probes and estimates and bring very fragmentary, though interesting information.

The studies of S.Zemlianoi indicate that some 200 to 250 thousand specialists per annum leave the territory of the previous Soviet Union, but it is not clear what is the share of research employees among them.

In the period 1980–1989 approximately 1.2% of total population have been migrating abroad. Some 12.1% of these migrants were university graduates (Tresteni, 1991).

The relatively most complete information on the *brain drain* were gathered in Bulgaria. A.Issifov said in his presentation at the conference in Venice that between November 1989 and September 1991 more than 250 thousand persons left Bulgaria and that 15 to 20% of them were university graduates.

2.4. The fundamental research areas in the study of the *brain flight* in Poland

We have indicated in the section presenting the state of the art of the research on the *brain drain* that the studies to date are characterized by inadequate representativeness.

During the preparatory work for our research project we took care to avoid this deficiency and to register possibly precisely the dimensions of the phenomenon studied in Polish science.

Such a recording is so valuable from the cognitive point of view that it is worthwhile to focus the fundamental scientific efforts around it, even at the expense of precise probing of the causes of migrations of the scientists. This is yet insofar justified as the causes are quite well identified and, as a matter of fact, quite trivial. It does not seem possible, therefore, that Polish studies could bring something new with this respect.

When reading the results of the studies to date one can hardly state

what are the actual losses borne by the science of a given country due to the *brain flight* phenomenon.

Are these losses limited to the decrease of the number of persons working in the most progressive sector of economy, or should we also account for the additional losses consisting in the fact that the leaving employees are the most dynamic and skilled? The present report tries to give at least a partial answer to this question, and besides this — to show the dynamics of the phenomenon in the years 1981–1991.

2.5. The principles of selection of the study sample

The study performed accounts both for the specific features of Polish situation and for the recommendations of the UNESCO conference on the *brain flight* from the countries of Eastern and Central Europe, which took place in Venice in November 1991. It was stipulated in the conference proceedings that, in particular, the studies be concentrated on the *brain flight* from selected domains of science, such as: biology, informatics, economics and physics (Task Force Meeting).

The specific features of Polish situation consist, it seems, in a particularly strong absorption of research employees by other sectors of economy.

Selection of the sample was also limited by the financial considerations, so that the decision was made to use the mailed questionnaire sent to all the scientific institutions selected for the study. An effort was made to encompass all the important university centers in Poland, according to the criterion of the number of persons employed in science.

On the basis of Statistical Yearbook 1991 eight greatest university and research centers were selected: Warsaw, Cracow, Wrocław, Poznań, Lublin, Katowice, Gdańsk and Łódź. These centers employed altogether 77% of all persons employed in science in Poland.

In the selected eight centers the study concerned universities, with exception of such schools as: physical education schools, fine arts schools, police, firemen and military academies, as well as theological departments and academies. All the institutes of the Polish Academy of Sciences were accounted for, on the other hand, irrespective of their location. Besides this, the study encompassed the ministerial institutes, active in research, located in the eight selected centers. The units not included were the so called development centers, design bureaus, libraries, archives and scientific associations.

The selection of the units included in the study was carried out on

the basis of *Informator Nauki Polskiej* (The Directory of Polish Science). Ultimately, the sample encompassed 2300 units such as institutes, self-standing laboratories, chairs etc. We have sent to all these scientific units a short questionnaire having the purpose of recording the phenomenon of the *brain flight* both abroad and to other sectors of economy (see Appendix).

The authors of the study have received a dozen letters accompanying some of the questionnaires. These letters contained additional information, opinions and comments. Almost all of the letters emphasized the need of undertaking such studies. Some letters indicated the inadequacy of the notion of the *brain drain* to the real nature of respective phenomena. One of the authors of letters sent to us wrote:

> *I am afraid of the false undertones of the questionnaire enclosed. We can namely speak of a "drain" in the case of "bribing" with extraordinary profits, while the persons leaving their home country are able of putting their gifts to use at home and to apply the knowledge acquired when their countries provide the necessary conditions for this. When, however, such positive conditions are not satisfied then in spite of "drain" one should rather be speaking of "saving" abroad of the intellectual potential which is condemned to waste in the country of origin.*

In another letter the author indicates yet one more cause of the *brain flight*:

> *I know the cases of forced* (underlining by the letter's author) *migration from Poland of persons who could continue their research abroad, due to a foreign offer, while their projects were rejected* (in Poland) *by the Committee for Scientific Research... Pushing thesci-entists below the level of social and intellectual needs forces many of them, especially the younger ones, to look for better sources of upkeep. This is formally not a drain, this is simply an outrage resulting from the shortsightedness of the previous and present decision makers.*

Numerous letters reflect the frustration and the discouragement of the scientists, who do not perceive the possibilities of a normal work at home. One of the letters was obviously caused by the apprehension that filling out of the questionnaire might put the director of the unit at risk of troubles. The contents of this letter was as follows:

The management... informs kindly that the present questionnaire does not concern our employees. All the members of teaching staff who go abroad in the framework of scientific exchange return in accordance with the dates established.

There was an exceptional letter expressing aggressive frustration (quotations given here are literal). Thus, this is what one of professors from Polish Academy of Sciences wrote to us:

The laboratory... received the questionnaire related to the study of the "brain drain" from Polish science. Without such a questionnaire we know that situation is catastrophic. The main cause of this phenomenon is well known: inadequate financing of science. And that is why I am of the opinion that the means directed to the study of the "brain drain" should be used for preventing such drain, i.e. for improvement of the financial situation of the centers threatened with bankruptcy. As the expression of such opinion I allow myself sending back to esteemed Professor the questionnaire not filled out.

2.6. The principles of estimation of employment levels in science in the years 1981–1984 and 1985–1988

The purpose of the questionnaire was to measure the dimensions of the *brain flight* in the years 1981–1991, while the data on employment, used as the reference point of this measurement, refer to 1991. The mailed questionnaire did not provide the possibility of asking detailed questions as to employment in particular years. This would namely require too much effort on the side of persons filling out the questionnaire, and besides this there would be numerous cases in which acquiring of such data could not be possible.

Thus, there appears the problem of the basis for calculating percentage ratios as the relative measures for 1980s. In order to solve this problem we have referred to statistical data on employment of scientific employees. Employment levels in science in Poland during the years considered in the study were as follows (the numbers given account for full-time equivalents): in 1981 — 69,638 persons, in 1984 — 65,737 persons, in 1985 — 66,037 persons, in 1988 — 66,607 persons, in 1989 — 67,639 persons, in 1990 — 66,569 (*Rocznik Statystyczny 1986, 1991*; for the years 1988, 1989 and 1990 — estimates) and in 1991 — 65,900 persons (*Rocznik... 1992*). These data indicate that employment in science in 1990 was lower by

4.4% than in 1981. The whole decade, though, was characterized by fluctuations: employment decreased by 5.6% in the period 1981–1984, then slightly increased — by 0.9% — in the years 1985–1988, decreased by 1.6% between 1989 and 1990, and, as the first published data for 1991 indicate, the decrease continued over the subsequent year.

As the result of our studies we obtained information from 1003 organizational units — institutes, laboratories, chairs etc. These units employed altogether 28,497 persons. Hence, the analysis performed concerned some 43.5% of all the persons employed in science. Thus, we can assume that the results are representative for particular centers and scientific institutions. Besides this, we are entitled to transform the data set obtained without running the risk of disturbing the relations deciding of the representativeness of the conclusions drawn therefrom.

In order to obtain the estimate of employment in the group of institutions considered we referred to the tendencies observed in the respective population for the whole of Poland. It was assumed that the number of persons in particular time periods was the same as in the initial year of this period. For the period 1989–1991, though, the average employment for 1991 was adopted, under the additional assumption that employment in 1991 did not differ significantly from that in 1990.

Assume that we would like to know the answer to the question: what should have been be the dimensions of the study sample in 1981 in order to encompass 43.5% of all the persons employed in science. A similar calculation was performed for the years 1985–1988. The results of these operations are shown in Table 2.2.

Table 2.2.

Estimates of the numbers of scientific employees for the years 1981–1984 and 1985–1988

Years	Total numbers of persons employed in science in Poland	Sample magnitude estimated under the assumption of encompassing 43.8% of all research workers
1981–84	69638	30335
1985–88	64432	28891

Source: own calculations on the basis of *Rocznik Statystyczny* for the years 1986 and 1991

The magnitudes indicated will be referred to in the calculation of percentage ratios for the periods of 1981–1984 and 1985–1988. The basis for the years 1989–1991, on the other hand, will be constituted by the number 28,497 of persons employed in science. It is on this group of people that we have obtained information during the analysis of the questionnaires received back.

2.7. The structure of the population analysed

The results of the analysis will be presented in the following settings: territorial, institutional, scientific disciplines, magnitudes of the research institutions, and also with respect o some definite units.

Warsaw is, of course, the center which dominates the scene in Poland, for almost 30% of persons employed in science work here. Then, there are four towns — Cracow, Wrocław, Poznań and Katowice — which employ between 10 and 15% of the scientists each. The smallest ones among the centers studies are Łódź, Gdańsk and Lublin. The shares of scientists employed in these centers are in the range of 6 to 7%.

Table 2.3.

The structure of employment of the analysed population of persons employed in science according to the centers

Center	Number of employees	% share
Gdańsk	2099	7.4
Upper Silesia	2861	10.0
Cracow	4343	15.2
Łódź	2122	7.4
Lublin	1759	6.2
Poznań	3223	11.3
Warsaw	8446	29.6
Wrocław	3644	12.8
Total	28497	100.0

The average magnitudes of the research units considered are illustrated in Table 2.4.

The study encompassed 1003 scientific organisms. These objects, referred to also as units, are defined as relatively independent formal organizational body registered in the *Directory of Polish Science*, active in the field of science and/or higher education in terms of research, teaching and

coordination of such activities. Thus, within the universities it is institutes, laboratories and chairs that are treated as units in our study.

Table 2.4.

The average magnitudes of scientific units and the % shares of their magnitude classes in the employment structure

Magnitude of a scientific unit measured with the number of employees	% share in total employment	cumulated shares
≤5	18.8	18.8
6–10 osób	20.1	38.9
11–15	13.1	52.0
16–20	9.7	61.7
21–30	9.6	71.3
31–50	13.7	85.0
51–80	7.9	92.9
≥81	7.1	100.0

N = 28.497

It can easily be seen that small or even very small research and/or teaching units dominate in Polish science. The units employing 10 persons or less concentrate altogether almost 39% of all the persons employed in science. Then, a bit more than half of all the scientists work in the units employing 15 persons and less. The greatest unit included in the study employed 457 persons.

The structure of employment of scientists according to disciplines is presented on the basis of classification founded upon the typology used in the reports of the OECD, adopted to Polish conditions (Frascati Manual, OECD 1981). In the framework of this classification we have distinguished these scientific disciplines which are of special importance from the point of view of the analysis of the *brain flight*, that is — economics, biology, medical sciences, physics and informatics (mathematics).

According to anticipations the greatest share in the employment structure is taken by persons active in engineering and technological sciences — 30.7%. Among the sciences on which our interest is focussed medicine comes to the forefront with 11%, and a relatively high share is taken by biology, 9.4%. Physicists constitute 6.3% of the sample analysed, economists — 4.4% and informaticians — 4.3%.

Table 2.5.

The structure of the analysed sample of scientists according to scientific disciplines

Scientific disciplines	In absolute numbers	In % of all the scientists considered
Engineering and technological sciences	8762	30.7
Medical sciences	3145	11.0
Humanistic sciences	3095	10.9
Social sciences and law	2583	9.1
Biology	2667	9.4
Physics	1785	6.3
Natural and geographical sciences	1425	5.0
Chemistry	1306	4.6
Agricultural sciences	1250	4.4
Economics and management	1251	4.4
Mathematics and informatics	1216	4.3
Other sciences	12	0.04

L = 28,497

Then, the institutional characteristics of employment are presented in Table 2.6.

Thus, majority of the scientists are employed in the categories of institutions referred to here as Universities — 24.0% and Technical Universities — 24.6%. Generally speaking, the greatest number of the research employees work in higher education — 72.0%. The institutes of Polish Academy of Sciences employ, on the other hand, just 10.3% of scientists considered.

Table 2.6.

The institutional characteristics of the employment structure.

Institutions	Absolute numbers of employed		% shares
Technical universities	7009		24.6
Universities	6830		24.0
Agricultural universities	2096		7.4
Economic universities	1367		4.8
Paedagogical universities	454	All the	1.6
Universities subordinated to		universities: 20515	
Ministry of Health Care	2759	i.e. 72.0%	9.7
Institutes of Polish Academy of Sciences	2938		10.3
Ministerial institutes:			
of Ministry of Industry	1897		6.7
of Ministry of Health Care	772		2.7
of Ministry of Transport	711		2.5
of Environmental Protection Ministry	487		1.7
of Ministry of Agriculture	410		1.4
State Agency of Nuclear Research	185		0.6
Other institutes	582		2.0

L = 28,497

3. THE MOBILITY OF RESEARCH EMPLOYEES AT HOME AND ABROAD

3.1. The internal and external *brain flight*

When using the notion of *internal brain flight* we refer to the phenomenon consisting in the previously signalled leaving of scientific jobs and passage to other sectors of economy in which higher salaries are offered. For purposes of further analysis we will assume that this phenomenon applies to all these persons who give up their jobs in science on own demand.

This, of course, is a simplification, it can be thought, though, in relation to a majority of persons abandoning science such an assumption is valid. Table 3.1. contains the information on the subject of discharges and foreign migrations of employees of scientific institutions according to the centers previously listed.

It can be concluded from Table 3.1. that if there were no internal and external *brain drain* the employment level in science could be by some 25% higher than it actually was in 1991. It is hard to state, though, whether we are dealing here with the decrease of Polish scientific potential by 1/4. In order namely to answer positively to the thus formulated question one would have to be sure that all those who left science had been rationally employed in science before.

It is worth noticing, though, that the losses of Polish science due to internal *brain flight* are much higher than those due to migrations. The latter namely decreases the human potential of Polish science by some 10%, while the search for better paid jobs within Poland entail the outflow of some 15% of scientists.

Table 3.1.

Scientific employees who migrated abroad and were discharged on own demand in the years 1981–1991 in eight scientific centers

Scientific centers	Persons discharged on own demand in % of employed in a given center	Foreign migrations in % of employment in a given center
Cracow	14.0	6.9
Gdańsk	10.1	9.5
Lublin	13.0	4.5
Łódź	16.7	7.7
Poznań	15.7	6.3
Upper Silesia	22.8	12.8
Warsaw	15.1	10.5
Wrocław	13.0	13.9
Total number	4313	2706
In % of total employment in 1991	15.1	9.5

What is the situation in different scientific centers against this background?

The greatest relative decrease of human potential in science was observed in Upper Silesia. Were it not for the discharges on own demand the employment of scientists in Upper Silesia could be higher by some 23%, and if, additionally, there were no foreign migrations of the scientists, the employment level could be higher by yet 13% more.

The relatively lowest level of the *brain flight* is observed in Gdańsk where there are 10% of foreign migrations and 9% of discharges on own demand.

In other scientific centers — excepting Wrocław — the situation does not differ much from the national average (migrations take a bigger share in Wrocław).

The question arises, of course, whether the relative decrease of the scientific potential — since a part of the jobs freed are again filled out by new scientists — resulting from the 10% of migration (6500 persons) and from the outflow of further 15% to other occupations in the country (approximately 9000 persons) over the period of 11 years should be considered important or not. In order to answer precisely this question we would have to dispose of the comparable data from other countries,

which we, alas, do not have. One can only notice that the migrants alone could just by themselves establish two new universities.

There are also countries of Western Europe which are subject to the phenomenon of the *brain flight*. This applies to Denmark, Ireland and even United Kingdom. In the first two cases mentioned the phenomenon results from the surplus of specialists in comparison with the internal employment possibilities, while in the United Kingdom it is caused by the restrictive policies of the state. Still, in all these countries the number of persons with university education and of university students is much higher than in Poland, where we are dealing with an acute shortage of staff with university education in general and in science in particular. Thus, the *brain flight* from Poland weakens the development potential of our country. In such a situation the current indicator of migrations of scientists can be treated as harmful. It attains alarming levels on the scale of particular institutions. A more in-depth analysis of individual cases shows the significant dimensions of losses, the more so that migrations are of selective nature and concern mainly the representatives of five disciplines: medicine, informatics, biology, physics and chemistry.

The numbers of persons who left particular scientific units and went abroad are of course not uniform. Among 1003 institutions studied there are 154 such that the indicator of permanent migrations abroad from them exceeds the average value by at least factor of two. If we account only for the units employing at least 10 persons the percentage share of those who went abroad ranges from 19% to 80% (see Appendix). There are much smaller differences between particular universities and institutes of Polish Academy of Sciences. Even in this subset, though, we can find some universities in which the indicator of migrations exceeds significantly the national average. These universities include, for instance, the Technical University of Wrocław (15.9%), the University of Warsaw (13.5%) and the Silesian Technical University (12.3%). Bigger differences can be observed, on the other hand, among the particular centers of Polish Academy of Sciences. The greatest outflow — in relative terms — occurred in Łódź (20%), in Wrocław (17.3%) and in Warsaw (13.4%).

The greatest outflow to other jobs within the country took place in the institutes of Polish Academy of Sciences in Silesia (41%), then at the Maria Skłodowska-Curie University in Lublin (24.7%) and in the institutes of Polish Academy of Sciences in Łódź (20%). The lowest values of the indicator of outflow of scientists to other jobs in Poland were observed, on the other hand, at the Catholic University of Lublin, Universities of

Poznań and Wrocław and the Jagiellonian University of Cracow, at the Technical University of Warsaw and finally at the Mining and Metallurgy Academy in Cracow.

This does not mean, of course, that employment in these scientific units decreased in just the degree indicated, for new persons were employed to replace the ones who left them. Taking, however, into account the fact that formation of a valuable scientific team lasts several years, we must conclude that such an important outflow of experienced scientific staff had to have a negative impact upon the work of institutions considered.

It is not easy to properly interpret the causes of differentiation among particular scientific units. In the case of migrations their intensity depends upon the strength of connections with outside world, since well developed foreign cooperation facilitates entering in contact and finding an advantageous contract abroad. High intensity of migrations from Silesia is caused partly by family connections with Germany. It is, on the other hand, much more difficult to explain important differences among the units involved in science as regards transition to other jobs in the country.

Let us now look at the mobility of the scientific staff according to the disciplines of science. Information on this subject is provided in Table 3.2.

Information presented in this table may be interpreted in terms of indication as to how many more employees could have worked in a given discipline of science in 1991 were it not for the migrations abroad and discharges on own demand.

The losses due to the internal *brain flight* are the most important in engineering and technological sciences — 20%, in economy — 28% and in law — 18%. The least relative outflow was observed in medical sciences — 6%, in physics — 7% and in humanities — 10%. These results seem to be in agreement with the common knowledge of the labour market in Poland. The results of our study appear, in particular, to confirm the existence of the process of absorption of engineers by the private sector of Polish economy as well as the increased demand for specialists in management and bookkeeping from the side of this sector.

The influence of migrations upon the employment levels in particular disciplines present a different picture. The greatest relative outflow in this direction, ranging from 12 to 14%, is observed in such disciplines as mathematics, medicine, chemistry, physics and biology. These disciplines are — as can be concluded from the studies carried out before and cited here — the areas of especially intensive exchange of scientific staff on the global scale. In this sense we can speak of a definite adaptation of the

patterns of migration of Polish scientists to the world market of scientific staff.

Table 3.2.

Persons having worked in science who were discharged on own demand or migrated abroad according to disciplines of science

Disciplines of science	Discharged on own demand in % of total employment in a given discipline	Migrants in % of total employment in a given discipline
Agricultural sciences	14.2	5.4
Biology	14.4	10.9
Chemistry	12.3	12.5
Economics & management	27.7	6.3
Engineering & technological sciences	20.1	9.0
Humanistic sciences	9.6	6.8
Mathematics & informatics	15.9	13.7
Medical sciences	6.5	14.0
Natural & geographical sciences	12.8	8.4
Physics	7.5	12.5
Social sciences & law	17.8	5.7

Another conclusion which can be drawn from our study relates to quite distinct differentiation of scientific disciplines from the point of view of their linkages with the home and world labour markets. Economics, law and technical sciences are linked with the labour market at home, while informatics, chemistry, physics, medicine and biology are linked with the world market.

This differentiation does not result from the levels of particular disciplines in Poland, but only from the tendencies on the international scientific market.

3.2. Political prerequisites for migration of scientists from Poland

We will now try to verify the proposition which has been signalled in the previous parts of the report, concerning the motivation to migrate.

It is usually so that the political reasons for migrations are being opposed to the economic ones. An important role is played in Polish conditions by the especially low salaries and difficult work conditions, resulting from the systematically inadequate financing of science, very slow growth

of the numbers of jobs in scientific institutions, liquidation of some institutes, lack of means for research, poor access to foreign scientific literature etc. Let us assume that the whole set of these conditions is represented with the economico-organizational hypothesis. It can also be assumed for purposes of further analyses that the economico-organizational hypothesis speaks of the key influence exerted by the wage factor and the state policy, the latter consisting in lowering of outlays into science and liquidation of jobs (in particular in the recent period) on the magnitude of migration abroad.

In further considerations we will subject the hypotheses of economico-organizational and political causes of migrations to verification. For this purpose we will present the information characterizing the dynamics of migrations in the years 1981–1991, together with the dynamics of layoffs and creation of new jobs in other sectors of economy in Poland. It is obvious that the latter are closely related to the wage levels. If it turns out that the average annual rate of new employment in other occupations in the country is similar to the average annual rate of foreign migrations, then we would be justified in stating that there is no superiority of political factors over the economic ones. We would then be dealing with the situation in which besides the economically motivated taking up of jobs in other sectors of economy there would be the migrational flow proportional to the latter as to its intensity. If, on the other hand, it turns out that the dynamics of migrations is not similar to the dynamics of layoffs then this would mean that the decisions to migrate are relatively independent of the salary fluctuations at home. Thereby, we would have to draw the conclusion that political factors are relatively stronger than the economic ones.

The dates shown in Table 3.3., limiting consecutive subperiods correspond to essential events of the recent history of Poland: in 1981 the martial law was introduced, in 1985 — the intensity of repressions was significantly relaxed, and in 1989 the systemic changes started. These limiting dates are simultaneously the time points strongly influencing the rate of outflow of Polish scientist abroad. And thus, in the period of martial law the average annual outmigration of scientists was 302 persons, after the martial had been suspended — 231 persons, and after the systemic changes have been started — only 191 persons per annum.

Let us now look at the dynamics of outflow to other sectors of Polish economy.

It can be concluded on the basis of Table 3.4. that taking up of jobs in

Table 3.3.

The magnitudes of migrations of scientific employees in the years 1981–1991

Foreign migration total, 100%	The % shares in particular subperiods		
	1981–1984	1985–1988	1989–1991
2706	44.6	34.1	21.2
Annual averages of migration numbers	302	231	191
In % of the numbers for 1981	100.0	76.5	63.2

Table 3.4.

Persons employed in science taking up jobs in other occupations at home in the years 1981–1991

Discharges on own demand, 100%	The % shares in particular subperiods		
	1981–1984	1985–1988	1989–1991
4313	26.0	33.2	40.8
Annual average numbers of persons	280	286	586
Ratio to the number for 1981, in %	100.0	102.1	209.3

other sectors of economy has exactly inverse dynamics to that of foreign migrations. Attention should especially be paid to the fact that the dates representing the subsequent stages of liberalization of life in the country are accompanied by increasing numbers of people leaving science in order to work in other occupations, this tendency being just the opposite of what has been happening with foreign migrations. And so, in the period 1981–1984 280 persons would leave science in this manner on the average during a year, in the period 1985–1988 the annual average was 286 persons and in the years 1989–1991 — as many as 586 persons. These data indicate that the internal mobility of scientists did not have a clear relation to political changes and its main causes were related to economic phenomena.

Besides this, it turned out that the fluctuations of the internal labour market did not exert such a clear influence upon the magnitude of migrations as the political factors.

One should conclude therefore that out of the two hypotheses being

verified here the political one explains much better the dynamics of migrations. Information provided in Table 3.3. indicates that approximately 37% of all the foreign migrations of Polish scientists can be attributed to political changes.

3.3. The "center – periphery" theory and the directions of migrations of Polish scientists

We do not refer to the center – periphery theory in order to verify it or to discuss the possibility of applying it in Polish conditions. Our intention is simply to put in order the empirical material at hand so as to be able to present it in a possibly clear manner.

Table 3.5.

Migrations of scientific employees according to years and countries

Countries and numbers of migrants in the years 1981–91 in % of totals		The % shares in particular subperiods		
		1981–84	1985–88	1989–91
USA	33.8	33.4	32.3	36.6
West Germany	23.4	20.9	27.2	22.6
Canada	13.6	15.4	12.9	10.8
France	4.9	4.6	4.6	5.7
United Kingdom	3.8	3.4	3.6	5.0
Other European	11.8	13.2	11.1	9.8
Other non-European	8.8	9.1	8.0	9.4
Total numbers of migrants	2706	1208	924	574

Our studies show quite distinctly that foreign migrations of Polish scientists take place in more or less constant directions, and are virtually not subject to variations in time.

What are, therefore, the countries which constitute the center from the point of view of migrations of Polish scientists? It is beyond doubt that United States, having attracted 33.8% of persons leaving the country, constitute such a center. Then, 23.4% left for Germany and 13.6% — for Canada. It should be noticed that the numbers of migrations to this latter country is decreasing in relative terms. It is, on the other hand, worth

noticing that the share of the countries of the EEC other than the ones listed is very small. Such a result seems to confirm the common opinion that the road to Europe passes through Germany.

4. THE PROFESSIONAL FATE OF THE EMIGRÉS

This chapter of the research report is devoted to the analysis of further fate of the migrants. We were primarily interested in the question whether the migrants are still working in science in their new countries of residence. Since the questions concerning migrants were answered by the managers of their home institutions in Poland, the vagueness and the information gaps had of necessity to appear, and could not be avoided.

We obtained reliable information as to the further fate of 990 migrants, of whom 614 work in science and the rest in other occupations. With respect to remaining persons we do not know whether they work in science or not.

In the course of subsequent considerations we will present information characterizing the present places of work of migrants according to residence location, institution and scientific discipline in Poland.

Thus, the highest shares of migrants who continue to work in science occur in Poznań and Łódź, 37% and 35%, respectively. These two towns are followed by Cracow with 30%.

Attention should be turned to the fact that only 14% of migrants from Upper Silesia found jobs in science abroad.

The information gathered during the study indicates that the employees of the ministerial (branch) institutes do take part in the *brain flight* to a lesser degree. This may mean that the world market of scientific labour is hardly absorbing the specialists of applied research and development. The skills of that type are namely often of less universal nature and are related to a concrete product turned out in a concrete plant.

In the population of migrants who left universities in Poland the high-

Table 4.1.

Migrants according to scientific centers in the years 1981–1991

Towns	Absolute numbers of migrants	% share of persons working in science
Cracow	298	30.5
Gdańsk	200	20.5
Lublin	79	20.2
Łódź	164	34.8
Poznań	203	37.4
Upper Silesia	365	14.5
Warsaw	891	19.2
Wrocław	506	21.5
Totals	2706	22.7 (614 persons)

est value of the indicator of relative employment share in science abroad is attained by the agricultural academies — 33%. Then, the shares of migrants from universities, technical universities and medical academies who find jobs in science range from 24% to 28%.

The lowest values of this indicator are attained by those migrants who had worked in Poland at the economic (14%) and paedagogical (0%) universities.

Table 4.3. contains data which suggest that biologists have the greatest opportunities of finding abroad a job in science, for the respective share for this discipline of science reaches 40%. The odds are somewhat worse (though still better than on the average) for physicists (30%), chemists (27%) and informaticians (23%). At the other extreme the lowest shares of migrants who continue to work in science occur in social sciences and law (13%), in economics, medicine and agriculture — 15 to 18%.

Summing up the considerations here presented one should state that the greatest opportunities of finding a job in science abroad were open to migrants from Łódź, Poznań and Cracow. If we look at this problem from the point of view of scientific institutions in Poland then we see that the highest numbers of migrants who continue to work in science come from universities, agricultural academies, technical universities, medical academies and from the State Agency for Nuclear Research. In the breakdown according to scientific disciplines a job in science is found most often by biologists, physicists, chemists and informaticians.

Table 4.2.

Migrants according to institutions

Institutions	Absolute numbers of migrants	% share of persons working in science
Agricultural universities	154	31.8
Universities	570	27.7
Technical universities	702	25.6
Medical academies	427	23.7
State Agency of Nuclear Research	43	23.3
Institutes of Polish Academy of Sciences	371	19.4
Economic universities	87	13.8
Pedagogical universities	11	0.0
Ministerial institutes:		
of Ministry of Industry	154	7.8
of Environmental Protection Ministry	37	5.4
of Transport Ministry	29	10.3
of Ministry of Agriculture	23	8.7
of Health Care	72	11.1
Other institutes	26	19.2

At a first glance it would seem obvious that if representatives of some university or scientific discipline do find jobs abroad more often than representatives of other universities or scientific disciplines then their skills correspond to a greater degree to the requirements of foreign scientific institutions. Such a statement is insofar more probable that a clear differentiation of Polish scientific institutions from the point of view of their capacity of preparation of their staff to scientific activity abroad can be observed.

On the other hand, though, the analysis of migration patterns from universities and institutes of Polish Academy of Sciences casts some doubts as to such regularity.

We could refer here to the tendencies on the world market of scientific labour, characterized, as we may remind, by relatively bigger absorptiveness with regard to the specialists of certain disciplines, especially the physicists and the biologists.

Irrespective of the above, one should pay attention to a certain heuristic incoherence of the results of the study. When analysing the numbers of migrants according to institutions and disciplines, we stated, namely, that the relation between the scientific work of agricultural and techni-

Table 4.3.

Migrants according to scientific disciplines

Scientific discipline	Absolute number of migrants	% shares of persons employed in science abroad
Biology	292	40.1
Physics	224	30.8
Chemistry	163	27.0
Mathematics and informatics	167	23.4
Natural and geographic sci.	119	21.8
Engineering sciences	791	21.1
Humanistic sciences	212	18.4
Economics and management	79	17.7
Agriculture	68	16.2
Medicine	441	15.2
Social sciences and law	148	13.5

cal universities and the requirements of the world market of science is relatively weak. Then, observation of the further fate of migrants leads to quite an opposite conclusion — namely that the employees of this kind of universities have greater opportunities of finding a job abroad. Such doubts imply that value judgments could be not sufficiently justified at this stage of analysis. There is one thing, though, that seems certain and not requiring further insights, namely a clear distinction between the ministerial institutes and the rest of the units considered in the study.

5. POLISH SCIENCE AND THE WORLD MARKET OF RESEARCH WORK

The present chapter takes up the problems signalled already before and related to the evaluation of the human potential of Polish science. We will try to establish what can be said of the state of Polish science on the basis of observation of Polish scientists who migrated abroad, with particular emphasis on their new jobs. Besides this, we would like to take up the problem of estimation of the costs borne by Polish science due to migration of persons employed in scientific institutions.

5.1. The principles of construction of hypotheses

It can be concluded from the analyses presented here that the ministerial institutes, with exception of the State Agency for Nuclear Research, do not correspond to the requirements of the world market of research work. That is why we will consider in the sequel only the situation existing in the universities and in the institutes of Polish Academy of Sciences.

When presenting the results of our research we have several times referred to the "center – periphery" theory. We will do it once again, but in order to better systematize the conclusions we will introduce a new construct, related to the world market of scientific work.

For purposes of further analyses we will introduce such an interpretation of the center – periphery theory which admits existence of a certain specific setting of relations between the countries of the center and the countries of the periphery.

These relations would consist, in the case of science, in the "insular" development of science in the peripheral countries. According to this interpretation there would exist in a peripheral country certain centers

featuring a relatively higher scientific level, rising above the national average. These scientific kinds of islands would maintain a close contact with science in the countries of the center. Staff exchanges between the center and the periphery would concern mainly the scientists employed in the "islands" of the peripheral country. It should therefore be expected that Polish scientists, who find employment in science in the countries of the center originate from the scientific organisms which differ from the rest by the nature of scientific activities, the institutional affiliation or geographical location. If these expectations turn out to be true, then we will be able to state that the patterns of migration may provide the instruments for evaluation of the level of Polish scientific institutions. The whole hypothetical setting outlined above will be referred to as the "hypothesis of insular development".

Verification of the "insular hypothesis" will consist in observation of scientific institutions. We will be interested in the relations between the institutional affiliation of the scientific organisms, the kind of scientific discipline, location in one of the eight urban centers, the numbers of persons migrating from a given unit and the number of persons who found a job in science in a foreign country.

If it turns out that the relation between the center or institution or discipline of science and work in science abroad are stronger than the relation between the number of migrants from a given unit and the number of those who take up jobs in scientific institutions in other countries, then we would be justified in concluding that the opportunities of finding a job abroad are for the employees of some scientific units in Poland higher than it would result from the distribution according to Gauss curve. Consequently, the more persons migrate from a given unit, the more of them find a job in science abroad. The arithmetical expression of this dependence is observed when the relation between foreign migrations and continuation of work in science is as strong as — or stronger than — the relation between the center, the scientific discipline or institution and work in science in a foreign country.

We are also distinguishing the competing "hypothesis of autonomous development of Polish science". This second hypothesis refers to the kind of scientific development which is mainly stimulated by internal demand. Such a hypothesis admits, of course, differentiation of the levels of scientific institutions in Poland. It should be emphasized, though, that this differentiation is — in accordance with the second hypothesis — due entirely to the action of internal factors.

The autonomous type of scientific development in a given country is not based, of course, upon the assumption of complete lack of relations with the world science, especially in the countries of the "center", nor on the assumption of the lack of migrations of scientific staff. In the case of such development the opportunities of finding a job in science abroad are not concentrated within a group of persons leaving some definite type of scientific units in Poland, but are dispersed and approximately equal for the whole migrating population of persons employed in science. This means that Polish scientific migrants finding jobs abroad are not distinct from the rest in terms of some special features related to education and skill level, scientific discipline or their home institution. These persons are characterized by more or less the same features as the whole population of Polish scientists employed in these units, from which the migrants originate, with a less or more the same intensity of the features. Let us remind here that the notion of all the population of scientists refers here uniquely to those employed at the universities and in the institutes of Polish Academy of Sciences within the eight urban centers mentioned.

5.2. The principles of construction of variables

The process of verification of the hypotheses presented before consisted in testing of the insular development hypothesis as opposed to the autonomous development hypothesis. Each of these two hypotheses contained a list of conditions which have to be satisfied in order to be able to positively verify it. In order to attempt to establish these conditions it is necessary to design the set of variables identifying them. The set of 1003 scientific units will be treated as the object of observation.

The following groups of independent variables were constructed for purposes of verification of the hypotheses:

— Scientific institutions, i.e. universities, technical universities, economic, paedagogical, agricultural and medical academies as well as institutes of Polish Academy of Sciences. If a given unit from the set considered was affiliated with any of these categories of scientific institutions the variable would take on the value $+1$, and -1 for all the other categories. We have thereby obtained 7 variables taking the values $+1$ or -1.

— Scientific centers: Warsaw, Lublin, Gdańsk, Upper Silesia,Cracow, Łódź, Poznań and Wrocław. These are subsequent eight variables

coded +1 or −1, depending upon whether a given scientific unit is located in the center (+1) or not (−1).

— Scientific disciplines: twelve variables coded, again, +1 and −1, depending upon whether a given scientific unit is active in the discipline considered (+1) or not (−1). The disciplines are: technical sciences, chemistry, physics, natural and geographic sciences, mathematics and informatics, biology, agricultural sciences, medicine, economics and management, social sciences and law, humanistic and artistic sciences, other sciences.
— Number of persons employed in a given unit in 1991.
— Interactive variables measuring joint influence of discipline, center and the institutional affiliation.
— Two intermediate variables introduced in addition to the previously listed ones.
— The number of persons continuing scientific work abroad was taken as the dependent variable.

5.3. Verification of hypotheses under assumed additivity of observed dependencies

In our further considerations we will present the results of verification of the two hypotheses formulated, carried out on the basis of the assumption of linear dependence among variables. In our case this assumption would stipulate that the same changes in the independent variables are accompanied by the same, proportional, changes in the dependent variables. The changes in the independent variables, used in the analysis, refer to the magnitude of standard deviations of the variables and their simple arithmetical functions.

In the first stage of the process of verification of hypotheses we calculated the correlation matrix of all the variables with two of them, i.e. with the number of migrants and the rate of continuation of scientific work. The measure of the strength of relations was expressed through the Pearson's correlation coefficient values.

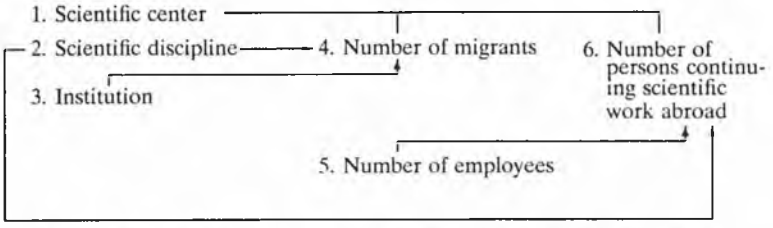
In the case of the thus numerous populations (1003 statistically significant cases) very low values of correlation coefficients are observed. Thus, when we conclude on the basis of this kind of coefficients, we can be sure of the validity of such conclusions, though, on the other hand, low degree of explanation of the dependent variable decreases the reliability of these conclusions.

In order to avoid this sort of pitfalls we assumed arbitrarily that a correlation coefficient is valuable from the cognitive point of view when at least one per cent of differentiation of variance of the dependent variable can be attributed to it. The measure taken here is the square of correlation coefficient, meaning that we will be interested in the coefficients equal 100 or more.

Then, we have selected these variables which correlated among themselves at the expected level and we subjected them to multiple regression analysis. The following path model was tested.

Diagram 1.

The path model of the dependencies identified with the standardized regression coefficients



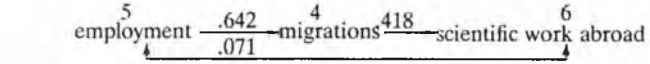
$R^2_{6.4,3,2,1} * 100\%$ = taking into account all the cases of not less than 22%

$R^2_{4.321} * 100\%$ = for all the combinations of not less than 6%

On the basis of the outlined manner of proceeding with the correlation matrix the group of variables denoted by numbers 1–3 was, in particular, selected. Within this group of variables the following ones were accounted for: centers — Warsaw and Lublin, scientific disciplines — technical sciences, physics and humanistic sciences, institutions — technical universities, agricultural academies and institutes of Polish Academy of Sciences.

The remaining centers, disciplines and institutions were rejected because the values of coefficients measuring the strength of their relation to the dependent variable did not ensure adequate statistical reliability. The remaining variable groups were consecutively subject to analysis by introducing them into the model in which the variables from the groups 4 to 6 were invariably kept. In this manner several dozens of regression

equations were constructed, compared then with the following sequence of dependencies:



$R^2_{6.4,5} * 100\% = 21.9\%$ $R^2_{4.5} * 100\% = 41.2\%$

All the remaining combinations in which scientific disciplines, scientific centers and institutions were included gave much lower values of regression coefficients, e.g. for the dependent variable "scientific work abroad" — not higher than 0.121.

These results demonstrate quite clearly that all the potential combinations of the scientific center, institution and discipline variables do explain the phenomenon of the manner in which Polish science functions against the background of world science to a much lesser degree than the sequence: employment, migrations, scientific work abroad.

Resulting from the calculations performed was the conclusion that the bigger the employment in a given scientific organism, the more scientists employed in it migrate, and the more persons migrate — the more scientific employees of the given scientific organism find jobs in science abroad. This means that for a significant majority of migrants the fact of working in a definite institution in Poland does not have the decisive influence upon the opportunities of getting employed in a foreign scientific institution. These opportunities are altogether similar for all the migrants.

All this inclines to adoption of the hypothesis of "autonomous development" and rejection of the hypothesis of "insular development".

On the other hand one could formulate reservations as to the manner in which the determinants of the phenomenon explained were treated, namely that they were taken separately and as additive ones, which is not necessarily reflecting the true nature of the phenomena analysed. It is namely not necessarily so that the level of the scientific units depends in a similar degree upon town, institution and discipline. One could rather expect that a specific combination of these factors may be correlated with the relatively higher scientific level of a given unit, and therefore the persons previously employed in this unit would have greater chances of getting a scientific job abroad. The subsequent fragment of our considerations is devoted to verification of this regularity.

5.4. Verification of hypotheses under assumed non-linearity of dependencies

In the course of further analyses the interaction dependencies were introduced into calculations. The meaning of interaction which is adopted in statistics links this phenomenon with existence of qualitative changes being the effects of occurrence of specific combinations of given variables. Thus, for instance, a specific combination of oxygen and hydrogen gives a qualitatively new entity which is neither continuation of hydrogen nor of oxygen.

When applying the phenomenon of interaction to our analyses we can propose that the chances of a migrant of finding a job in science abroad could best be explained by the specific combination of institutional affiliation of home unit, assignment to a scientific discipline and location in a scientific center. Thus, for instance, relatively higher chances of finding employment in a foreign scientific institution have biologists from the Naval School in Gdańsk. In further analyses we will be testing this kind of interactions.

The starting point, similarly as in the case of testing of additive dependencies, will be constituted by the model shown in Diagram 1. It will be our task to check whether a specific combination of the three factors considered in our analyses improves the chances of a migrant of getting a scientific job in a foreign country.

In order to fulfill this task we have constructed interaction variables measuring the hypothetical interactive influence of particular combinations of the scientific center, scientific discipline and institution. Then, an appropriate number of equations were generated for testing the contribution of the interaction variables into the explanation of differentiation of the dependent variable.

Calculations were performed according to the scheme of standardized multiple regression.

Two groups of regression equations were constructed. The first group of equations was meant to measure the additive and interactive influence of the triple of independent variable groups on the rate of employment abroad, and the equations generated would take the following general form:

$$\text{employment in science abroad} = \text{scientific center} + \text{scientific discipline} + \text{institution} + (\text{scientific center} * \text{scientific discipline} * \text{institution})$$

This general form of equation would accommodate consecutive variables from the three factor categories.

The second group of equations contains the previously described sequence: employment magnitude, migrations, employment abroad. The prediction power of both kinds of equations would be compared. If it turns out that equations of the first group have bigger explanatory power then this would be an argument for accepting the first hypothesis. If, however, better predictions are achieved with the second kind of equations, then acceptance of the second hypothesis will be more justified.

The calculations carried out demonstrated that the equations which included the interaction variables gave the level of explanation of the dependent variable not greater than 7%.

The second equation, of the type: employment magnitude + migrations = employment abroad in science, gives 21.9% of explanation of the dependent variable.

The results of calculations speak quite unequivocally that the empirical material gathered is explained much better by the second hypothesis than by the first one. Thus, we must state that the relation of a vast majority of Polish scientific institutions to world science has autonomous character. This means that the scientific level attained by majority of Polish scientific organisms results primarily from stimulation with the internal factors.

Conclusions

We have encompassed with our observations eight greatest Polish scientific centers. We tried to determine the factors which are decisive for the chances of taking up jobs in science abroad by migrating Polish scientists.

Due to the analyses performed it turned out that these chances are rather uniformly distributed in the population analysed, consisting of 1003 scientific units. This means that observation of Polish migrants working abroad cannot constitute the basis for evaluation of Polish scientific institutions from the point of view of their "better" or "worse" quality. This is not to say that we aim at questioning of the differentiated level of Polish scientific institutions. Such a differentiation exists and it may even be quite important. The empirical data gathered by us indicate simply that the chances of getting employment in science in a foreign country are more or less the same for the employees of Polish scientific institutions characterized by the higher and lower scientific levels.

Would this mean that the level of Polish science is extremely high? Not

necessarily. We should note, namely, that the level of scientific institutions abroad is differentiated as well, and we do not know to which the migrants analysed find their ways. Notwithstanding these doubts the stimulators of the development of science existing at home are sufficiently effective to ensure, on the average, acquisition of skills and knowledge that are comparable with those that are required of the scientists in the countries of the "center".

The results of our studies compel to reject the hypothesis proposing that the scientific migrants be characterized with a special set of features, distinguishing them from the rest of population. It should rather be admitted that the population of scientific migrants has *en masse* the very same features we haveidentified in the whole population of the employees of Polish universities and of the institutes of Polish Academy of Sciences.

Shortly speaking, observation of the *brain drain* phenomenon leads to the following conclusion: it is not true that the foreign migrations of scientists constitute the process of selection of individuals characterized with certain specific features. It is rather so that the group of migrants maps out and transfers abroad the features acquired in Polish scientific institutions in general.

6. CONCLUSIONS AND RECOMMENDATIONS

The classical approach to the *brain drain* problem is the derivative of the studies on relations between the Third World and the highly developed countries, inspired by the theory of division of the world into the center and periphery. In 1990s the studies of the *brain flight* from Central and Eastern Europe were started.

The most important causes of migrations of scientists include: lack of jobs in the home country, low salaries, lack of possibilities of professional development as well as political factors in the countries with authoritarian rgimes which constrain freedom of speech and freedom of scientific research.

There is also a common opinion that foreign migrations of persons employed in science are a disadvantageous phenomenon for their country of origin.

The directions of migrations are conform with the "center – periphery" scheme. The country which attracts the greatest numbers of migrants are United States, followed by United Kingdom.

The majority of studies to date devoted to the phenomenon of the *brain flight* operated on small samples with undefined level of representativeness.

The study here presented was based upon the questionnaire mailed to scientific units in eight urban centers concentrating scientific activities. The study encompassed altogether 1003 scientific organisms employing 28,497 persons. This made it possible to represent quite precisely the structure of employment of Polish science according to centers, types of institutions, magnitudes of units and scientific disciplines.

The analysis of migration patterns and of the internal professional fluctuations of scientific staff shows that the greater influence on the de-

crease of human potential of Polish science is exerted by internal *brain flight* (15.1% of total employment in science) than by foreign migrations (9.5%).

We obtained quite a clear picture of differentiation of organizational prerequisites of migration and taking up of jobs in other occupations in Poland. The demand generated by Polish economy for the representatives of technical and economic sciences is relatively the greatest. On the other hand, migration patterns show a relatively greater demand for biologists, informaticians, physicists, chemists and representatives of medical sciences.

The numbers of migrants before and after 1989 make the importance of political motivations of foreign migrations of scientists quite evident. It can be assumed that the political fluctuations of 1980s caused the increase of the number of migrants by more than 30%.

Application of the center – periphery theory to the analysis of the empirical material of the study leads to conclusion that the center in terms of migrations of Polish scientists was constituted by USA, Canada and Germany.

Our observations encompassed eight largest scientific centers in Poland, identified with urban agglomerations. Effort was made to determine the factors decisive for the chances of taking up by migrating Polish scientists the scientific jobs abroad.

As a consequence of the analyses performed we could conclude that these chances are rather uniformly distributed in the studied population of 1003 scientific units. This means that observation of Polish scientists working in scientific institutions abroad cannot constitute the basis for evaluation of Polish scientific units in terms of their classification into the "better" and "worse" ones. One must not take this as implying that the differentiation of the scientific level of Polish institutions engaged in research and university education should be questioned. Such differentiation exists and it is certainly quite significant. Still, the empirical data gathered by us imply a more or less equal chances of getting employment in science in a foreign country for the scientists working in Poland in institutions having both higher and lower scientific level.

Would that signify a truly high level of Polish science? Not quite so. One should namely remember that the level of scientific institutions abroad is also differentiated and we do not know the kinds of institutions in which Polish scientists find employment. However these things may be, the stimulation of the development of science in Poland, functioning

within the country, is insofar effective that it ensures getting skills and knowledge altogether comparable to those required of the scientists in the countries of the "center".

The results of our analyses make it possible to reject the proposition that migrating scientists are characterized by certain specific features, different from those concerning the whole population. It should rather be assumed that the population of migrating scientists has, on the average, the same features which exist in the population of all the persons employed as scientists in the universities and in the institutes of Polish Academy of Sciences.

Summing up, observation of the phenomenon of *brain flight* makes it possible to state that it is not true that migration of scientists is the phenomenon which acts selectively and filters out persons with certain particular features, but rather that the group of migrating scientists represents and transfers abroad the features acquired within the Polish scientific institutions.

How, then, will look the perspectives of integration of Polish scientists and other highly qualified staff with the international market of intellectual work, against the background of the analysed phenomenon of *brain flight* from Polish science and the conditions on the European market of highly specialized labour?

In the period of real socialism Poles and Hungarians were enjoying the greatest possibilities of travelling and the greatest freedom of action abroad among the nationalities inhabiting Central and Eastern Europe. Scientists, who could obtain scholarships or be visiting professors and employees of enterprises which were carrying out their contracts abroad (in particular, starting with the beginning of 1970s, the specialists engaged to work in the countries of Africa and Middle East through the intermediary of the specialized firm "Polservice") had the broadest possibilities of temporary stays in foreign countries.

There were also specialists from other countries of the previous socialist block that were employed on foreign contracts, but their status abroad was beyond comparison with that of Poles and Hungarians. And thus, for instance, Bulgarians, Russians and Rumanians who worked in 1970s in Algeria were quartered in isolation from the rest of society and had to give the respective embassies all their earnings, receiving back only a modest sum necessary for living. When, in spite of these restrictions their succeeded in economizing enough to buy an old car, they had to obtain the approval of the ambassador for the purchase. Although it is

true that Poles, Hungarians and Czecho-Slovaks were obliged to pay the firm which served as the intermediary in getting the job some share of their salaries (approximately 20 to 30%), they enjoyed complete freedom in all the other matters.

A part of those scientists and highly skilled specialists who went officially abroad in connection with scholarships and contracts remained out of Poland, settling mainly in the United States, Canada, France and Germany (West). Having usually certain economized sums and contacts with the representatives of other countries dating from their previous period of work or stay abroad, they could get, as a rule, a job in their profession.

The fate of the participants of foreign excursions from Poland, who decided to stay abroad for good was quite different. The members of this group, irrespective of skills they might have had, very often landed at the margin of the respective societies.

Silesians enjoyed a special status, for they were treated as Germans in West Germany. They would obtain financial assistance for the adaptation period, the offer of language classes and, potentially, also skill upgrading courses. There was a strong migratory wave at the beginning of 1980s, and an important share of the migrants did ask for the status of political refugees. It became much more difficult to obtain such a status in the second half of 1980s so that the migrants from that period had incomparably worse adaptation conditions.

Having even a temporary job abroad was some time ago a very attractive thing for Poles due to exceedingly high exchange rates of Western currencies. Several hundred dollars changed into Polish zlotys constituted an enormous sum, equivalent — in accordance with this marginal exchange rate — to a few years' salary, since the average wage was equivalent to just some 20 US dollars. In other countries of the previous socialist block the dollar exchange rate was never as attractive as that.

The situation changed radically in 1990. Poles cannot any longer apply for the status of political refugees and therefore obtain corresponding assistance. The dollar exchange rate moved from the marginal one to a more purchasing power based, which made a temporary, underpaid work abroad much less profitable.

The situation on the labour market, especially on the market of highly skilled labour, changed significantly as well. New private or commercialized economic agents, and mainly banks as well as foreign firms are on the lookout for specialists, and they offer salaries that are several times higher than those that can be attained in the state sector, and especially in

the so called "budgetary sphere". There is progressing internationalization of economy and an increasing number of Poles will be employed in the branches or bureaus of foreign firms active in Poland (such as Unilever, Philips, Henkel or Fiat). Thus, the multinational corporations will most probably become — similarly as in other countries — the main channel of migration of specialized staff.

There are certain domains in which there is a significant shortage of qualified staff on the global scale (these domains include, for instance, informatics and biotechnologies). In these domains Polish specialists are already being sought and can easily find employment. The spreading knowledge of languages in the present generation of students and pupils, and especially of the English language, will also constitute a factor advantageous for growing migration flows. Students are more and more often going abroad within the framework of various international programs for the period of one of two semester of studies.

The highly skilled personnel will more and more often be included in the international flow channeled through the intermediary of multinational as well as Polish firms, conducting business out of Poland. There are several firms in which salaries of managers are already comparable with those of Euro-managers, though near to the lower limits in this category. Most of them, though, earn much less. The equivalent of 12,000 US dollars a month is considered a good salary, which is a dozen times less than on the international market. In spite of lower living costs in Poland (by some 25%, excepting apartment rents paid by Poles) this sum is still far too low against the European background.

On the other hand, there will be more and more of highly skilled personnel coming from other countries appearing in Poland because of taking jobs in the firms with foreign capital. The situation, in which a Pole, having the same skills and working on an analogous position as a foreign specialist, earns several times less, cannot persist for a longer time.

It is also necessary that Polish firms and institutions set in motion the program of schooling abroad, since the cooperation with the EEC will not be possible without adequate knowledge and skills. Such schoolings will, however, be effective and not entail the *brain flight* only under condition of guaranteeing the managerial salaries in Poland comparable to the European ones.

The situation is much worse, though, even catastrophic, in research and university teaching, where professor's salary is equivalent to some 2500 US dollars a year, and together with quite unsure additional earn-

ings it may amount to 5000 US dollars. If such a situation persists over the next few years it may entail liquidation of Polish science and university and impossibility of reproduction of highly skilled personnel. The consequences of such a state for the future of our country are obvious. Poland, similarly as other countries of Central and Eastern Europe, is the area of *brain flight*, and if this phenomenon is not stopped, all the development possibilities will be closed.

The main brake of migration of Polish specialists abroad is constituted by lack of international experience — excepting the domains of science and engineering — and lack of adequate knowledge of languages. Until 1989 Polish students had had no possibility of studying at Western universities, and their only contact with the outside world — very important, anyway — was tourism, whose purpose was often to earn some money abroad.

The situation changes very quickly, though, international programs are being started, making it possible for Polish students to stay for a few months in foreign universities, and there is growing knowledge of foreign languages. Thus, better conditions for the *brain flight* are being established.

The political and ideological motivations for migration are now absent. There are, however, apprehensions that along with increasing ideologization of public life, which can be observed already now, the threats for the freedom of scientific research may arise. The prenatal studies and the fertilization *in vitro* are being limited already now. It cannot be excluded that tomorrow this or another form of censorship will constrain the freedom of opinions which could be inconvenient for some spheres, like the clerical ones. Science, as is known, cannot develop freely when it is subject to limitations of ideological nature.

All the specialists agree that at the beginning of 21st century science and knowledge will become the main factors of development. One could refer here, for instance, to the recent publication by the outstanding analyst of the modern world and the keen futurologist Alvin Toffler (1991).

A country which will not be developing university education and scientific research has no chances whatsoever of surviving as an independent state. The expenditures of the state budget on science and university education in Poland have been decreasing for several years already. This disadvantageous tendency should be reversed as soon as possible, even though the country is going now through the period of decrease of the domestic product value.

In order to avoid catastrophe it is necessary to close the salary gap in

university education and research existing presently between Poland and Western Europe. This would mean raising of the respective salaries in Poland by the factor of five to six, such an operation being possible, alas, only at the expense of other social groups.

It is also necessary to modernize the research equipment and to intensify research in the selected directions, the ones which are the most promising from the point of view of potential results to be obtained.

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