SCIENTIFIC PERSONNEL IN ESTONIA DURING THE TRANSITION PERIOD

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The present paper is the first presentation of the results of the project carried out under the aegis of the Commission of European Communities in East European countries, which focused to the processes concerning international migration and possible brain drain effect during the transition period among the scientific personnel.

To understand the scope, pattern, impact of the transition period in the East European countries the idea about the common project was initiated already in 1991 [Rhode, 1991]. However, the project itself was launched only in 1993 and carried out through 1994-1995. The project launched 2 standardised surveys focusing on the changes in the process of restructuring science in these countries and to its effects. Thus, the data was gathered from general statistics, by a special survey on the scientists who have left scientific institution (hereafter referred to as real migration survey) during 1989-1994 and by the questionnaire launched for the scientists employed in science in 1995 (hereafter referred to as potential migration survey). The first part of the analysis concentrates on the general background of the transition period in Estonia from the viewpoint of overall economic, population and migration processes and the relevant changes in the structure of science. The second part analyses the first results of the survey carried out in the scientific institutions for the period of 1989-1994 evaluating the scope and patterns of reduction of scientific personnel, so-called real migration trends over the transition period in the field of science. The third part concentrates to the main outcomes of the survey carried out among the scientists currently employed and trying to assess the potential for migration, including evaluating potential of brain drain, brain exchange and brain loss directions among them.

The paper is the outcome of the collaborative work of Estonian Interuniversity Population Research Centre (Kalev Katus, Allan Puur, Asta Pôldma, Luule Sakkeus), the Working Group (Katrin Paadam, Mare Ainsaar, Hill Kulu, Rein Vöörmann, Leena Rôbakova). Dr. Helle Martinson, Estonian Scientific Foundation, has written the chapter *1.3. The Reform of the Research and Development System in Estonia.* The project was made possible by the grant of European Economic Commissions CIPE-CT-93-6155 as well as the contributions by the Estonian Scientific Foundation grant 1484 and grant R-96/14 of Tallinn Pedagogic University.

I BACKGROUND INFORMATION

1.1. ECONOMIC SITUATION IN ESTONIA

All the transition economies have shown the similar pattern of severe decrease of industrial output, high inflation rates, negative international trade balances, unbalanced budgets for the whole period from 1989-1994. None of the East European countries has by the current state recovered the levels of industrial output or GDP before the transition period. However, 1994 has shown first marks of recession of these trends for most of the East European countries as well as for Baltic states. Among the last group of countries, Estonia has shown the best results from the economic point of development in overcoming the unfavourable trends of transition period [EBRD 1994; OECD 1993; UN ECE 1995]. Estonia's better position among other Baltic States and comparable results with the best performing economies like Czech Republic and Slovenia among East European countries might be explained by different reasons. Estonia was the first among the countries of the former Soviet Union who started to deteriorate from the common Soviet Union policy already in 1987. Already in the framework of the Soviet Union legislation the concept of economically autonomous Union republic was adopted in 1989, which helped to separate the countries budget from federal one, establish an independent tax system, trade to be based on market relations and enterprises to become more self-reliant. Further steps in economic restructuring taken in 1989-1991 before the regaining of political independence were headed towards fast liberalisation. It is evaluated by Estonian economists [Taaler 1995] that liberalisation was carried out at a much higher rate than was the rate of emergence of the two main components of market economy - private ownership and competition. Systematic economic reforms and stabilisation were hindered by the fact that Estonia remained in the rouble zone up to its monetary reform in the second half of 1992. Due to these conditions Estonia has not been able to avoid catastrophic decline and hyper inflation during the initial period of reforms compared to the similar stages in other East European countries and it is estimated that the decline of living standards of the population has been three to four times [Taaler 1995].

However, data for 1994 showing economic recovery for East European countries and among others Estonia involves decline in inflation, rapid expansion of export and recovery of investments, stability and free convertibility of domestic currencies and controlled public finances. For 1994 Estonia has shown zero growth of GDP, sharp increase in exports [UN ECE 1995]. One of the main characteristics of the recovery pattern is the development of private sector. The share of output generated by private business activities has further increased in 1994, and accounts for more than 50 per cent in countries such as the Czech Republic, Hungary, Poland, Russia and the Baltic states [EBRD1994].

Although the economic performance has shown unquestionably reassuring tendencies, it must be reminded that output and consumption are still much below the pre-transition levels, especially for south-east European countries and Baltic states. The prospect for sustained growth depends mostly on the domain of savings, investment and financial stability, as well as the continuation of export expansion and improved access to western markets. By the opinion of the UN economic survey for Europe the key factors behind emergence from the 'transitional' recession are early reforms combined with consistent and comprehensive economic policies. So, Hungary, Poland, Slovenia and Estonia, having adopted radical approach to reforms in the initial stages of the transformation have put financial stability, liberal market environment and fairly efficient state as the key formations for their economic growth in the early stages of restructuring economy.

UN ECE forecasts for Estonia for 1995 are in general favourable, indicating that Estonia is going to keep its front runner position among the three Baltic states,

foreseeing possible GDP growth, ' mainly fuelled by vigorously expanding services sector, increasing exports (with a large re-export component) and foreign direct investment' [UN ECE 1995, p.203]. By the opinion of Estonian economists the most crucial problem of Estonian development is low labour productivity. Labour productivity growth should increase the competitiveness of Estonian exports and improve the balance of payments, which also could increase the low income level without transmitting increased wages in the cost of production, thus keeping lower inflation rate and domestic prices [Rajasalu 1995]. However, it might hamper the situation in labour market.

As an implication of the trends in economy during the transition period the development of science in that context should be borne in mind when evaluating the impact of the changes:

(1) Estonia as a country of former Soviet Union was as concerns the sphere of science to a considerable extent financed centrally from Moscow. Having initiated the independent line of economic development already in the framework of the entity of the Soviet Union, it hampered considerably the development of science already at the early stages of transformation by reducing the available resources significantly. On one hand, it made inevitable the quick restructuring in the scientific area. On the other hand, the reduction of funding has not been halted: in the budget of the country the proportion allocated for development of science has remained one of the lowest among all the East European countries.

(2) Year 1992 has been for Estonian economy the severest year, which is characterised by the deepest decline of GDP, sharpest decline in the export volumes, highest inflation rate, decline in private consumption due to a significant loss of savings. On the other hand, year 1992 is the turning point for the Estonian economy, which was initiated by the currency reform in the middle of 1992 and further liberalisation policy, enabling to develop the private ownership with great speed, quick orientation from Russia's market to western markets in foreign trade. Thus, it also affected the restructuring of the scientific sphere (see below). Until 1992 almost half of the funds for science outside of Estonia came still from Russia, which together with the currency reform came to halt and made the science quickly to reorientate itself looking for other sources.

1.2. DEMOGRAPHIC SITUATION IN ESTONIA

Estonia and northern Latvia have historically been among the forerunners of the demographic transition in Europe [Coale, Härm, Anderson 1979]. The beginning of the demographic transition in Estonia could be traced back to the middle of the 19th century. As a leading nation in fertility transition, France is the only European country having both overall and marital fertility lower compared to Estonia in the 1880s. Without any doubt Estonia stays among countries with early fertility transition. One of the first nations in the world, Estonian population reached the under replacement fertility in the 1920s [Katus 1991].

Mortality transition had progressed alongside with the fertility decline. Estonian mortality exceeded some of the European countries, particularly because of relatively high infant mortality. In general, Estonia was a forerunner in mortality transition to a lesser extent compared to introduction of parity-related family planning. However, Estonia was in leading position in mortality decline among East European countries.

However, as marked by different population researchers [Coleman 1995] after the II World War the historical Hajnal line has been pushed more further to West. During the last half of this century, social conditions have been very different from those in Western countries [Katus 1990; Zvidrinsh 1978], thus affecting significantly the basic demographic processes.

1.2.1. Impact of population crisis

The development of the Estonian population has been greatly affected by II WW and, in particular, by the following consequences of the war. Estonia lost its major minorities during II WW (Germans were repatriated in 1939-1941, Swedes escaped in 1944, Russians living in mixed-population area were annexed to Russia in 1945). In addition, human losses of war activities and post-war sovetization of Estonia between 1940-1953 are estimated not less than 17.5 per cent of the total population [Katus 1990].

When dealing with any aspect of the post-war demographic development in Estonia, the impact of incorporation into Soviet Union must be taken into consideration. Among the consequences of the post-war demographic development a radical change in the ethnic composition of the population deserves particular attention. Being a nationally homogeneous country (Estonians formed 97.3 per cent of population in 1945) has become a country of residence for more than hundred different ethnicities during the last 50 years. Non-Estonians comprised ca 40 per cent of the total population by 1989.

Exceptionally from the general European trend, Estonia remained the country of low fertility during the post-war decades. No baby-boom broke out and fertility was constantly below the replacement level with TFR 1.9-2.0 in the 1940-1950s. At the end of the 1960s fertility trend changed principally. The period fertility of Estonians rose more than 17 per cent in four years (1971 compared to 1967). No fertility increase was observed among non-Estonians, their fertility trend had followed their country of origin.

Fertility in Estonia reached a peak in 1988 when the period total fertility rate equalled to 2.26. It was the highest level recorded in Estonia at least for the last 80 years. Next year the moderate decrease was introduced and the sharp decline followed in the 1990s: TFR has dropped from 2.21 in 1989 to 1.4 in 1993. It is not clear to what extent the recent fertility decline reflects a new pattern of reproductive behaviour, or whether it might be regarded as a period effect. Regardless its origin, the fertility decline has already caused a serious discontinuity in the population age structure.

The pattern of mortality in Estonia is similar to that of Eastern European countries, with a particularly prolonged stagnation. The present life expectancy, 65.72 years for males and 75.04 years for females (1986/1991), was already achieved in the early 1960s. The significantly high sex difference in mortality, accounting for 10 years in life expectancy has disbalanced the proportion of males and females among the elderly. Last years have exhibited even decrease in the life expectancies.

The trend and causes of mortality indicate towards unhealthy life style, social stress and pollution. Currently, the influence of these factors has been augmented by the economic crisis resulting from the transition to market economy.

Starting from 1991, a natural decrease in the population has been recorded. Without substantial immigration during the Soviet period, this situation would have emerged already in the 1970s (as it emerged for Estonians). Currently, the drop in fertility levels combined with advanced level of population ageing and relatively low life expectancy have resulted in the world's quickest population decline.

As a result of the early timing of demographic transition, the process of population ageing started relatively early in Estonia. Mass immigration during the post-war period retarded the process of population ageing in general. In the 1970-1980s the proportion of elderly remained stable in Estonia. In 1991 the proportion of population over 60 years of age was 17 percent.

Behind this general trend lie distinctive differences in the degree and pace of ageing of native and immigrant population. Due to the prevalence of young individuals among migrants the immigrant population is characterised by relatively younger age structure than native-borns. However, due to its instable age structure, resulting from the past migration waves, immigrant population is expected to age more rapidly during the coming decades.

The recent decline of fertility and changes in net migration have contributed to the acceleration of population ageing. During previous decades, inadequate attention was paid to adapting the socio-cultural environment to meet the needs of the aged and disabled. As a consequence, Estonia has to make substantial investment to provide the minimum of requirements in housing, services, medical care, transportation etc. Unlike the experience of most European countries these investments must be made in a short period of time and under economic crises.

Since 1989 Estonia has experienced the similar to other East European countries trends in the main demographic processes: catastrophically sharp decrease in fertility indices (TFR for Estonia amounts to approximately 1.3 by 1994), after 30-years' of mortality stagnation at the life expectancy being around the level of 70 years, it also is showing a decrease. Estonia among other East European countries is distinguished by high rate of suicides (together with Hungary) and by the largest differences between males and females in life expectancy. Having been historically among the forerunners of demographic transition, it has contributed to the fact that by the beginning of 1990s Estonia together with Latvia are among those who experience the severest population decline in the world.

Implications to the scientific sphere:

(1) ageing of the population structure is one of the main features which also impacts the age structure of the scientific personnel
(2) the rapid population decline during the transition period together with the ageing process puts the labour productivity problem as a cornerstone for any economic development. The enforcement of this key issue at all levels is one of the major basis in order to secure any improvement for resources in science
(3) the differentiation of the total population of Estonia into two main sub-populations - native and immigrant - has had minor effect to the scientific personnel. Imported development structures at all-Union-oriented branches were closed down when the independence was regained and the institutions left together with the immigrant personnel.

According to the data from 1989 census, among the scientific personnel Estonians formed 73 percent, Jews 5 percent, Finns 0.5 percent. It has to be borne in mind that the census does not allow to identify the purely involved in science and higher education, as the latter comprises also from personnel in vocational education. However, the scientific personnel of Slavic origin (Russians, Ukrainians, Byelorussians) formed 22 percent, of which 55 percent were engaged in research institutions (together with branch-profiled and locally not integrated institutions) and 45 percent were engaged in education sphere (together with vocational education). Among this sub-group 29 percent are born in Estonia and 37 percent speak Estonian language. Although the composition of the scientific personnel cannot be examined more thoroughly in retrospective terms, in its major part it has been of native-born origin and only 15 percent of the science personnel in 1989 was foreign-born and thus mainly oriented to the centralised All-Union needs.
(4) the deepest economic decline in 1992 and the reduction of scientific personnel for the same year might be regarded also as the response to the restricted funds. However, it might also be regarded as the response to the efficient restructuring of science.

1.2.2.International migration

The political events after the Molotov-Ribbentrop agreement in 1939 not only had a political impact but also significantly affected the demographic development of the Baltic countries, especially in Estonia and Latvia. One reason for the demographic impact was that Estonia and Latvia were much more advanced in the demographic transition than the other parts of the USSR. The remainder of the USSR was at the stage of the formation of an intensive migration potential. Thus, the remainder of the USSR operated as a vast hinterland, with the Baltic States serving as an attractive potential destination for migrants [Vishnevsky et al. 1983]. On the basis of the current statistics through 1945-1991 the great impact of immigration from former Soviet Union to the Baltic states can be especially underlined, the latter forming to a great extent the basis for the current problems in the field of population, especially related to Estonia and Latvia [Sakkeus 1995].

The Slavic ethnic groups that came to form large sub-groups in the Baltic States were at the stage of the demographic transition in which their migration potential was increasing rapidly. This phase of the demographic development of the Slavic ethnic groups, along with particular characteristics of the Baltic States, led members of Slavic groups to fill openings in the labour pool in the Baltic States. Characteristics of the Baltic States that contributed to Slavic immigration include the more developed infrastructure, extensive development of the economy, the deportation and emigration of large numbers of the native population, and high labour-force participation rates. In contrast, Lithuania, which was at a similar stage with the European part of Russia, Ukraine and Byelorussia in its demographic behaviour, experienced mainly the impact of the first post-war forced administrative immigration of Slavs.

The main reason for the current problems must be seeked in the different timing of demographic transition in Estonia and Latvia compared to the other parts of former Soviet Union. The data of 1989 All-Union census gives grounds to speak about the greatest share of foreign-born population in these two countries in the context of all Europe, the foreign- born population whose migrational, demographical, cultural, historical and ethnic behaviour considerably differs from that of the native population [Sakkeus 1994].

Together with other heavy burdens inherited from the 50-years' Soviet rule, the needs of different sub-groups of the population only add to the current difficulties as in economic as well as in social aspects.

After the World War II the majority of external migrations of Estonia occurred between Estonia and USSR. The volume of migrations was particularly high in the immediate post-war period, most of all due to the forced migration (administrative and military immigration from USSR, deportations of Estonians etc.). Characteristic to migrations between Estonia and USSR is a fact that a large number of immigrants used Estonia for short-term residence reflected in the extensive migration turnover.

According to the official records immigration flow into Estonia has decreased since 1989. The trend towards decrease of immigration from previous USSR has been realised in the turnaround of net migration. However, statistics on migration should be regarded with caution as the estimations based on vital statistics indicate a sharp increase in the number of illegal immigrants from East for the same period.

The Soviet period has left Estonia with a substantial number of immigrants. In its pattern of urbanisation, regional distribution, educational and occupational structures, social and demographic behaviour, the immigrant population differs markedly from the native-born population. Frequently these dissimilarities are interpreted as ethnic inequalities and are used as a political argument. Above-discussed historical differences in timing of demographic transition are continuously of great importance to understand

the present population and social developments in Estonia. In spite of considerable time passed since the transition era and despite the last five decades of unifying Soviet rule, the heterogeneity of demographic behaviour of population still exists. From the viewpoint of Estonia, the modern impact of historical differences are of special importance: immigrants from the Eastern regions of the Soviet Union to Estonia in years of the Soviet period have brought along the demographic behaviour characteristic to their native regions, and the country has become heterogeneous in terms of population development.

However, in connection with scientific personnel, it must be pointed out that science had remained during the Soviet era mostly the area where native-born population was engaged. The intermediate scientific structures imposed by the centrally commanded (mostly of military origin) ministries were not integrated into the local scientific environment and with their withdrawal as the personnel who had worked for Moscow-centred needs, had gained the materials from Moscow and sent the results to be used to Moscow had no local basis anymore, having themselves been of immigrant origin, they also left together with the leaving structures. Thus, the emigration to East practically did not have an impact on the national scientific structure.

Emigration for permanent stay to West has been and still is very low in Estonia. Mostly the background to it lies in the early demographic transition of the Estonian population. The following reasons could be underlined:
(1) demographic transition has been similar to most western societies by timing and pattern of most demographic processes
(2) Estonian population, having passed the period of demographic transitions, does not have migration potential in its population structure, including the population engaged in science
(3) emigration to west for permanent stay has included mostly family migration, lower educated people, which is a great difference from other East European countries
(4) however, the impact of temporary emigration has increased significantly. Mostly this aspect is paid attention to in the current survey, in order to estimate these volumes. The aim is to evaluate the patterns of temporary migration in regard to its direction and volume, identifying the competing areas and place Estonia with its trends among the other East European countries.

1.3.THE REFORM OF R&D SYSTEM IN ESTONIA

The reform of scientific establishment in newly independent Estonia was started in the period of declaration of sovereignty of Estonia (November 1988), when the country was still a part of the former USSR. In this period the idea of "Economically Independent Estonia" was developed. In the framework of this programme the legislative and institutional changes in the science establishment were designed and started.

The restoration of the independence of Estonia in August 1991 totally changed the political, economic and social situation of the country. The status and functions of higher education and R&D system in the national economy changed radically. Once again Estonia became a small independent state, whose needs and possibilities differ completely from the needs and possibilities of a former periphery republic of the large empire.

The first stage of the reform of science in Estonia was aimed mainly at introducing new principles of research funding, at building up a system of science councils and expert commissions and drafting the basic documents for the new structures. At the same time a thorough evaluation of science in Estonia, at first, of research projects (1990-91, carried out by Swedish experts) and then the institutions (1994, conducted by local commissions) was carried out. The reform of the whole research establishment created

during the years of Soviet occupation was being prepared. This stage was ended in December 1994 with passing the Law on Research and Development and the Law on Universities in the Estonian Parliament (Riigikogu). At the same time, the restructuring of the institutional system of science was started.

The first key question was the re-organisation of the budgeting system by introducing the financing of the research projects and researchers in the form of grants. Another significant issue was the re-organisation of research establishment and the status and functions of the Soviet-type Academy of Sciences in the new economic and social environment. The third key problem was the reform of the higher education establishment, the professional training of researchers in the new environment and the reform of the system of academic degrees.

In 1990 three foundations - the Estonian Science Foundation (ESF), the Informatics Foundation and the Innovation Foundation, each with its own council, were established to cover the financing of all the stages of R&D. As an "umbrella" above these foundations the Estonian Science Council (ESC), an advisory body at the Estonian Government was formed. The financing system was changed in 1991. From this year the state budget money for the basic and, partly for the applied research has been delivered by the Science Foundation.

In 1990 the reform of the system of academic degrees was started. Two degrees were established: the Master and the Doctor. They are awarded by the universities only. The degree of Candidate and Doctor conferred on scientists in the years under Soviet power are valid and do not belong to re-certification. Parallel to creating of a new system of science councils some of the old decision-making structures - the Presidium of the Academy of Sciences, the science departments at some ministries - persisted. The main difference was that the leading structures of the Estonian Communist Party disappeared.

In 1991, the ESC became the main decision-making body in R&D policy. Its main function was to advise the Estonian Government on the matters of science, development and technology as well as on university education. In December 1993, the ESC was reorganised into the Research and Development Council (RDC). The Prime Minister of the Estonian Republic became the Chairman of this council. The RDC decides the principles of distribution of resources between the research areas; takes part in the formulation of the state budget on R&D; represents the interests of Estonia at the international level on the matters of R&D. In opening, restructuring and closing of research institutions the Government proceeds from the suggestions made by the RDC. The ESF Council is another level of decision-making on the matters of the development of research. It makes the main decision on distribution of the research money.

1.3.1 Research System

The two most important complexes of research institutions in Estonia are the research universities subordinated to the Ministry of Culture and Education and the research institutions of the Estonian Academy of Sciences. The other research institutions are under the auspices of the Ministry of Agriculture, the Ministry of Social Affairs (medical research), the Ministry of Economics and the Ministry of the Environment.

In 1990-94, considerable changes took place in the research system of the Estonia, mainly with respect to the former branch institutes and other sectoral research institutions. During the first years of restructuring of the Estonian industry most of independent scientific research organisations as well as construction and technology units at various enterprises have changed their field of activities and form of organisation.

Several branch institutes, subordinated to the ministries of the former Soviet Union, were re-organised into joint-venture companies. Some institutes were liquidated, some united with other institutes. On the other hand, 10 new research establishments came into being owing to disintegration of the "mother-institutions". The number of research institutions in Estonia is given in Table 1.

Table 1

The number of research institutions in Estonia in 1991-1994

Institutions	1991	1993	1994
Universities	6	6	6
Estonian Academy of Sciences Research Institutes	17	20	21
Other research institutes	18	18	17
Wild-life preserves, national parks and environmental laboratories	*)	10	10
Research-conducting museums	*)	10	10
Research-conducting archives	4	6	6

*) not counted

During the last 4 years the university reform was started. The number and diversity of higher educational institutions in Estonia has changed considerably. In the days of Soviet period numerous technical schools functioned in Estonia. By now some of them have been re-organised into state (applied) higher educational establishments. The other class of new institutions is private higher schools (Table 2).

Table 2

The Universities and other higher educational institutions in Estonia

	Academic years			
	1990/91	1991/92	1992/93	1993/94
Universities	6	6	6	6
State higher schools	-	4	7	8
Private higher schools	-	1	1	8

Under Soviet regime the university research and the research done in the institutes were kept separate by various departmental and organisational barriers. Their essential unity was abolished, official co-operation between the universities and other research institutions was possible only in the limits of various prescriptions. Now the co-operation of researchers and university professors is encouraged. In 1993-94, a number of leading researchers of the Academy of Sciences were elected to the posts of professors at the universities. The post-graduate students work part of their tuition period in the institutes of the Academy of Sciences.

Several new faculties and research units both at the universities and research centres (and laboratories) attached to the Academy of Sciences institutes have been born with the help of scientists as well as research and other organisations from abroad.

Some progress, although slow, has been made in developing the science and technology parks. Another positive trend is the appearance of spin-off firms, joint ventures and small enterprises at research institutions and universities. At the Academy of Sciences alone there were 23 such organisations in 1991.

1.3.2. Human Capital

The years of the Soviet occupation (1940-1991) was a period of unifying the education. The current education system covered general education, vocational

education, secondary specialised education and higher education. Estonians (and Russians as well) were able to be educated in their native languages. In 1990 there were 6 higher educational institutions in Estonia with 25,899 students. The number of students in higher educational institutions per thousand of population was 15.4 in 1985 and 15.2 in 1993 i.e. it has not diminished considerably.

In 1991/92 the number of students per thousand of population was 17.1 for Latvia and 15,9 for Lithuania. These numbers were a little higher than for Estonia. In Bulgaria the corresponding number was 11.3 in 1985 and 19.2 in 1993, in Czech Republic the numbers were 10.6 in 1985 and 11.1 in 1993, in Romania 7.0 in 1985 and 10.3 in 1992, in Poland 7.6 in 1985.

In comparison with the other Eastern European countries the number of students in Estonia per thousand of population is high. But in OECD countries the numbers are much higher: in 1988-89 in Austria - 25, Belgium - 26, Denmark - 24, Finland - 28, Netherlands - 29, Norway - 26.

Table 3 shows the dynamics of the total number of students in higher educational institutions. During the ten years period it has remained almost stable. But in the last four years the number of students has decreased by about 10%. The fall of the number of university students has been greater - about 24%. With diversifying the scale of higher educational institutions the share of students studying in private institutions has increased rapidly.

Table 3

Number of students in higher educational institutions

	1985/86	1990/91	1991/92	1992/93	1993/94*
Universities	7 339	8 020	24 880	22 875	19 707
State higher educational establishments	16 177	17 879	763	1 422	1 824
Private higher educational establishments	-	-	162	167	1 683
Total	23 516	25 899	25 805	24 464	23 214

* The data represent educational level categories 5 and 6 and include 20 institutions

As the statistics of the former SU did not give the data on the students' specialities it is not possible to analyse the distribution of university students by specialities in this period. One can find these data only for the universities' graduates. The distribution (%) of university students by groups of specialities in Estonia and some other East European countries in 1990s is given in Table 4.

Engineering and social sciences dominated in all countries observed in 1990. By 1993 the share of students in the field of engineering sciences diminished, the share of social sciences grew. This dynamics reflects the opening of new specialities needed in new socio-economic conditions. In Estonia the percent of students in the field of agricultural sciences dropped significantly. For Estonia the field "others" covers mainly the humanities. The percentage of students in this field is much higher than in other countries who have presented their data on students' specialities.

The statistics in the former SU did not present the total number of persons engaged in the science sector. The data on researchers and research funding was quite modest. There were special, more detailed surveys on research personnel in every 5 years. The last surveys were done for the years 1982, and 1987. These materials were "for official use". But these surveys concerned only researchers and post-graduate students.

Table 4

Distribution of students by field of study, %

	Estonia		Czech Republic		Romania		Slovenia	
	1990	1993	1990	1993	1990	1993	1990	1993
Engineering	34.9	26.8	35.4	31.9	64.9	46.2	27.7	25.6
Medical Sci	6.7	6.0	10.1	9.9	10.2	10.1	5.7	5.5
Natural Sci	5.6	5.1	4.3	5.0	5.8	9.0	5.8	3.1
Agricultural Sci	16.2	6.6	8.9	7.3	3.9	3.9	4.0	4.3
Social Sci	21.9	39.0	39.1	43.6	14.2	27.9	50.2	56.2
Others	14.7	16.5	2.2	2.3	1.0	2.9	6.6	5.3

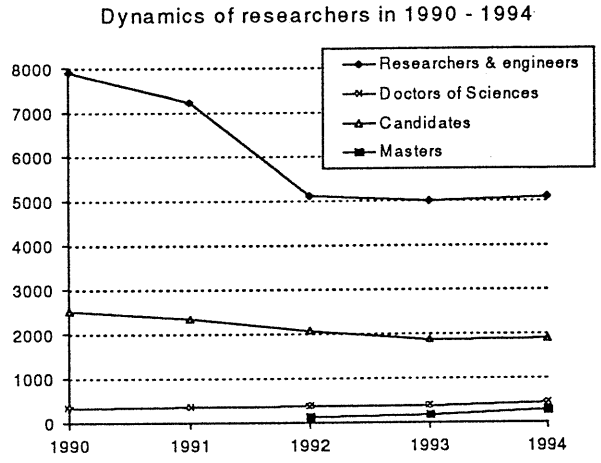
The surveys on age-distribution of research personnel were also carried out once in every 5 years, the last ones were for 1983 and 1988. It is the reason why we do not have the data for the years 1985 and 1990. In 1991, in the course of reform of R&D organisation, a new system of science statistics, designed for OECD-countries in "Frascati Manual" was introduced in Estonia. The dynamics of the number of researchers and engineers (r&e) in the period of the new statistics system (when only those actively engaged in research are counted and their number is determined according to the time dedicated to research) is given in Table 5 and Figure 1.

Table 5

Distribution of R&D personnel by occupation

	Researchers and engineers		Technicians	Auxiliary personnel	Total R&D personnel
	Number	Full-time equivalent	Number	Number	Number
1991	7 227	6 601	1 176	4 074	12 477
1992	5 104	3 896	571	3 143	8 818
1993	4 996	3 812	691	3 109	8 796
1994	5 079	3 244	843	3 180	9 102

Figure 1



According to the data the total number of research personnel in research institutions has decreased very rapidly (ca by 30%) in 1991-93. In 1994 there was a little growth, but it was rather due to the widening of the scale of institutions taken into account than to the increase of the number of personnel. In 1985 the percentage of researchers of the total workforce was 0.88, by 1993 the percentage of r&e of the total workforce had dropped to 0.76 in Estonia. In 1992, the number of man-years for R&D per 1000 capita of labour force was only 5.72, e.g. 1/2-1/3 of that in the leading OECD countries. The dynamics of research personnel in three Baltic States is given in Table 6.

Table 6

The number of research personnel and researchers in the Baltic States

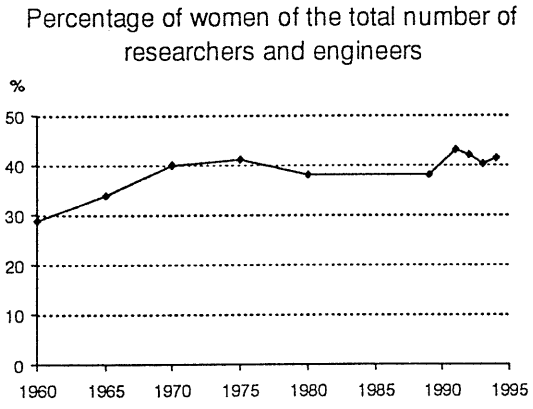
		Research personnel total	Researchers
Lithuania	1990	no data	1 489
	1994	26 455	6 389*
Latvia	1990	30 700	17 700
	1994	5 239	3 010**
Estonia	1990	over 21 000	7 150
	1994	9 102	5 079

* The researchers with academic degrees and titles

** Researchers and engineers

The decrease of the number of people working in the sphere of science as well as the number of researchers or researchers and engineers (in Estonia) has been considerable. The decrease of the number of researchers was the least in Estonia - 29% in 1990-94, in Lithuania it was 57% and in Latvia - 83% (!). It is clear that the critical border has been achieved. Although the decrease of the scientific personnel is many-folded: structure of statistical coverage of institutions has changed, often the previous data recorded persons involved not paying attention to the person-years, the insufficient financing of the transition period has paid a significant role in this reduction. On one hand, it reflects more actually the real personnel involved, but also it refers to different directions of movements among the research personnel. The current report, relying on the survey data hopes to highlight the main directions of the mobility and identify the directions in respect to internal and external brain drain, brain loss and brain exchange. However, it seems that further decrease of the number of research personnel would lead to the collapse of the whole research system for many transition countries.

Figure 2

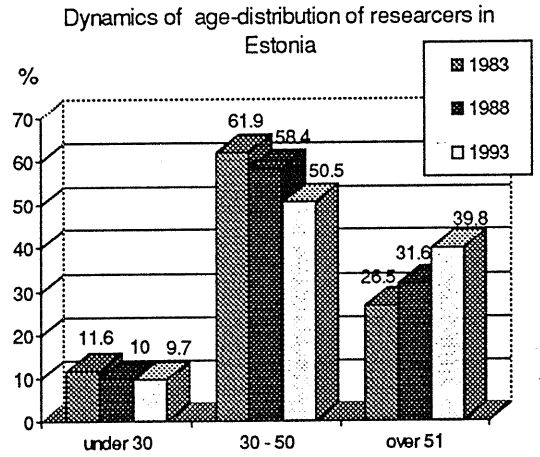


In the group of East European countries the percentage of researchers of the total workforce was in 1993 the highest for Slovak Republic - 1.34, for Bulgaria it was 0.67, for Czech Republic 0.49, for Romania - only 0.21. For Latvia it was only a little more - 0.27, for Lithuania - 0.59.

There is no data on the distribution by sex of total personnel in the science sector in Estonia until 1990. The percentage of women in science has been quite high in Estonia during Soviet period. By archive data - about 52-54% of the total personnel were women. In comparison with Latvia (50.0%), Poland (48.5%), Slovakia (42.5%), Bulgaria (39.5%) and Czech Republic (37.0%) the share of women in total personnel was higher in Estonia in 1990 (52%) and in 1993 (51.7%) as well. The proportion of women among researchers and engineers has been by about 10% lower than among the total personnel. During the last years the proportion of women among r&e has decreased from 43.1% in 1991 to 40.2% in 1993. In 1994 it was 41.3%. It seems, that the cutting down of the research staff has affected women more than men (see Fig.2).

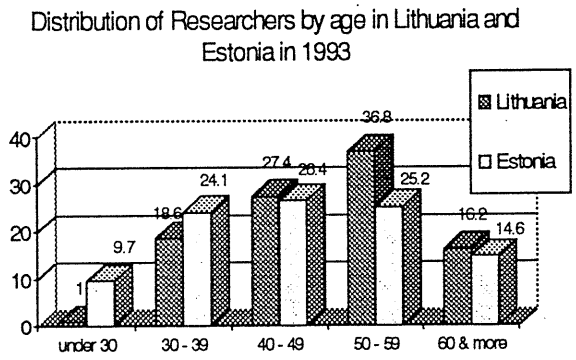
There are no women among the members of the Presidium of Estonian Academy of Sciences. The percentage of women of the total number of doctors of sciences was only 14.8 in 1994. But it was already 4.4% higher than in 1991 (10.4%), when the doctors had got the degree from the Supreme Attestation Committee of the former SU. Amongst Candidate's degree holders 30.1% were women in 1994 (in 1991 - 31.5%), Master's - 38.2% in 1994 and 47.2% in 1991.

Figure 3



As it was mentioned, we cannot follow the dynamics of age distribution of the total science sector personnel in Estonia. The data is available only for researchers. The dynamics of age- distribution of research personnel during 1983-1993 has been somewhat alarming: the share of aged researchers has been growing constantly and, correspondingly the share of people under 40 years has decreased (Fig.3). It is a serious problem which reflects the change of preferences of young people. However, it also corresponds to the general trends in the population development where Estonia is showing rapid ageing trends.

Figure 4



The situation is even worse in Lithuania (Fig.4), which however cannot be characterised by the similar speed in the overall ageing of the population. In some other Eastern block countries the dynamics has been unpropitious as well (see Table 7), but the dynamics has been much worse in the Baltic States.

Table 7

Science Sector Personnel by Age, %

Number of Employees in Science Sector		Country		
Year	Age	Bulgaria	Slovenia	Romania
1985	Under 30	8.0	15.8	
	31-50	68.7	62.6	
	Over 50	23.3	21.6	
1990	Under 30	7.3	19.5	14.4
	31-50	66.1	60.4	67.3
	Over 50	26.6	20.1	18.3
1993	Under 30		18.5	13.0
	31-50		61.6	66.0
	Over 50		19.9	21.0

During the period 1985-93 the distribution of researchers by scientific disciplines in Estonia has changed a lot, partly due to change of statistics system (Figure 5).In 1993 there were great differences in the distribution of science personnel by fields of sciences not only in the Baltic States but between Estonia and other East European countries as well (Table 8).

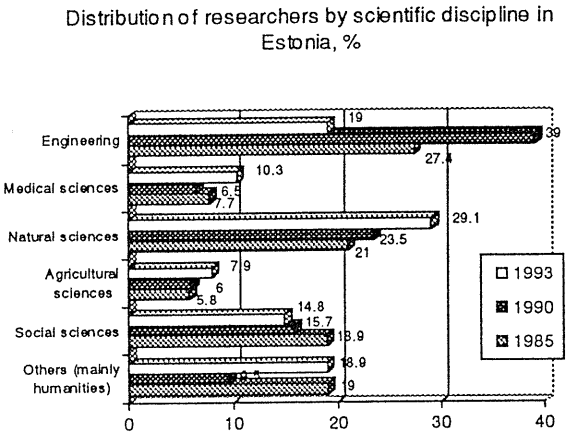
Table 8

Distribution of researchers (and engineers) between the fields of science in 1993, %

	Lithuania*	Latvia	Estonia	Bulgaria	Czech Rep.	Slovenia	Romania	Poland 1990
Natural sciences	23.0	41.8	29.1	19.9	18.3	12.8	8.5	15.6
Engineering	25.8	33.4	19.0	32.7	52.3	45.9	78.5	66.0
Medical sciences	14.2	4.6	10.3	18.2	16.5	17.3	5.9	5.0
Agricult. sciences	9.0	7.1	7.9	6.2	5.4	7.1	6.9	7.0
Social sciences	12.3	7.5	14.8	23.0	7.5	10.5	0.1	6.4
Humanities (oth)	15.7	5.6	18.9	-	-	6.4	0.1	-

* % of the science personnel as a whole

Figure 5



The main difference concerns the share of researchers in the field "engineering", which is the largest in East European countries. Estonia is the last in this succession. The percent of engineering scientists in Estonia has dropped in comparison with 1980s. The most evident explanation is that the Statistics Department of Estonia has not included development organisations into the lists of questioning. The share of researchers in the field of natural sciences and social sciences, adding humanities is much bigger in the Baltic States than in other countries. Although retrospective comparative data is scarce and only some countries can be compared by the structure of scientific fields over 10 years, the data reveals, that Estonia has had different structure of scientific fields as compared to Latvia, Slovenia, Poland and Bulgaria (Table 9) over the time. Estonia is characterised by the far more larger share of social sciences together with humanities than all other countries under comparison. It has been mainly at the expense of lesser share in engineering-technical fields. Baltic states as compared to other East European countries all show the greatest proportion of those engaged in the natural sciences as in a narrow sense as well as in a broad sense (together with medical and agricultural sciences).

The distribution of research personnel by types of organisations in 1985-93 in Estonia is illustrated by Figure 6.

Table 9

Science Sector Personnel by Scientific Discipline

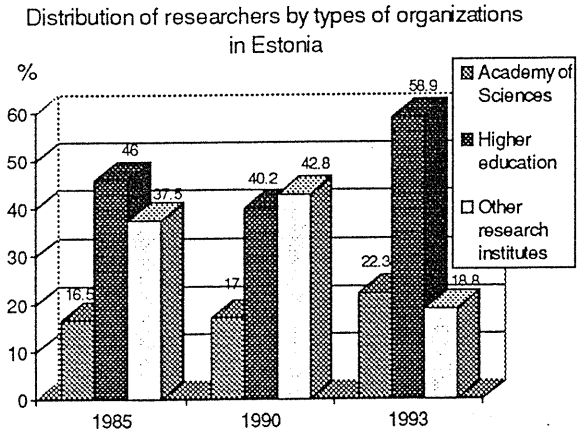
Year	Scientif Discipl	Country							
		Bulgar	Czech.	Sloven	Poland	Latvia	Lithuan	Estonia	Romani
1985	Engin - techn	10 208		7 423	71 993	5 546		1 904	
	Medical	4 492		1 768	8 011	846		535	
	Natural Science	4 490		1 135	11 297	3 398		1 464	
	Agricult	2 126		350	5 751	530		416	
	Social Science	5 575		1231	5 648	1 694		1 315	
	Others			637		1 522		1 325	
1990	Engin. - techn	12 905		6 795	54 647	10 038		2 925	18 980 (1)
	Medical	4 573		1 927	4 124	424		487	981 (1)
	Natural Science	5 459		1 569	12 913	5 455		1 763	2 506 (1)
	Agricult	2 089		898	5 755	472		438	1 635 (1)
	Social Science	6 678		1404	5 311	1 652		1 173	1 491 (1)
	Others			745		938		715	2 709 (1)
1993	Engin. - techn	8 583	12 722	5 721		1 338	3 666	950	18 380 (2)
	Medical	4 796	4 020	2 155		184	2 002	517	1 390 (2)
	Natural Science	5 227	4 437	1 593		1 672	2 354	1 451	1 977 (2)
	Agricult	1 632	1 310	883		283	1 287	395	1 620 (2)
	Social Science	6 046	1 828	1301		299	1 744	741	3 (2)
	Others			795		223		942	3 (2)

(1) 1991
(2) 1992

The universities have been dominating during the whole period, except the year 1990. Other research institutions have hold the second place. But in 1990s their share has dropped considerably due to liquidation of a number of former all-Union branch institutes and research units at the enterprises. Another reason is that the Estonian Statistics does not record data on development organisations.

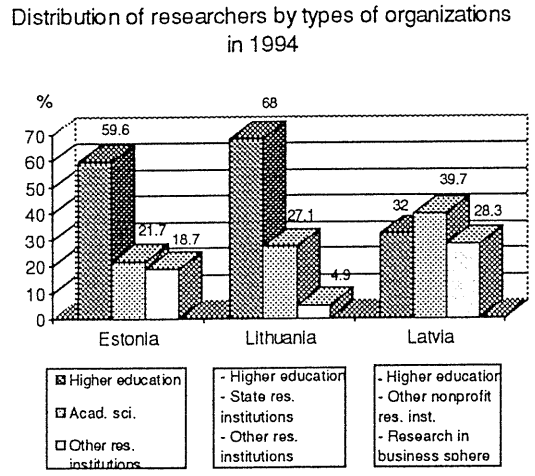
As the system of research organisations has changed considerably in all Baltic States and East European countries during 1990s and the statistics systems are not yet comparable it is not practical to try to draw parallels between different countries. For the Baltic States the situation in 1994 is illustrated on Figure 7.

Figure 6



Despite the myth that "the research community is too large for a small country" which became popular in the governing circles of Estonia at the beginning of the 1990s, the decrease of the total number of research personnel by about 30% in 1990-94, especially in the institutions doing research for the business sphere (45%) has been distinguishable. It seems, that some critical border has been achieved already, as it is an overall regularity that the research community must have a "critical mass" to do high-level research. Cutting down their number or even eliminating only the less productive researchers inevitably leads to sinking of the level of research.

Figure 7



When Estonia was incorporated into the Soviet Union, the Soviet system of academic degrees was introduced. That system (as well as the whole system of the management of Soviet science) was characterised by rigid rules and regulations and a high degree of centralisation. The degrees of Candidate and Doctor of science were awarded by the councils of the universities and research institutions, from 1975 - by the specialised councils. Their decisions had to be confirmed by the Supreme Attestation Committee (SAC, established in 1936) in Moscow.

The system of academic degrees in Estonia was changed with a government decree from July 16, 1990. The regulations for granting scientific degrees in Estonia, introduced in 1990, were founded on the following principles:

- two academic degrees were established: the Master's degree and the Doctor's degree (PhD) that were similar to the degrees of the Western countries. The Soviet Candidates of Sciences may call themselves Doctors but will remain be Candidates in all official documents
- the procedures for getting the Doctor's degree were made much simpler, most of the bureaucracy was cut out. The degree is to be granted for a high-standard professional research, the results of which have been published in international, reviewed scientific journals
- the Master's degree is not a prerequisite for the Doctor's degree
- universities take full responsibility for the scientific degrees they grant and for the training of the research staff. The decision of the university council is final
- all procedures concerning the defending of theses and granting degrees must be simplified. Every university will lay down its own rules of procedure.
- the scientific degree itself must not grant any material privileges. The scientist's salary must not directly depend on his scientific degree.

The Law on Universities fixed the academic degrees of Bachelor, Master and Doctor. It also established the general rules of tuition the student has to pass prior to the defence of the dissertation. The Bachelor-tuition is the first stage of academic education. Its nominal duration is established to 4 years, at the end of the tuition the student must defend the thesis.

The Master-tuition (educational level category 7 by ISED classification) is the second stage of academic education, after getting a Bachelor degree. Its duration is 2 years, after the study-course the postgraduate student has to write his master - thesis. The thesis can also be defended without a study-course, the procedure must be established by the council of the university.

The third stage of tuition is the doctoral education (educational category 8). Its nominal duration is 4 years. The Doctor's degree is given by the council of the university after the defence of a dissertation.

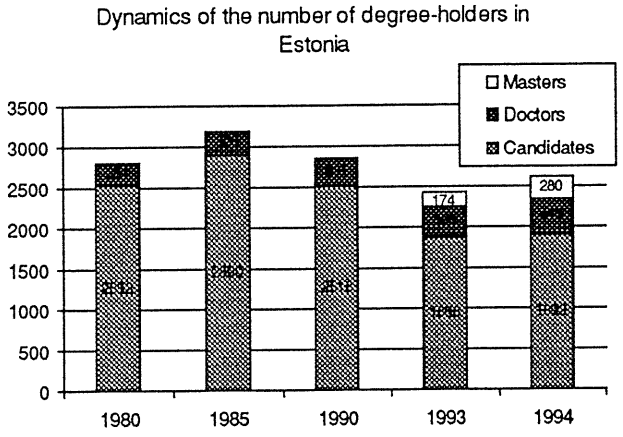
There were 1554 postgraduate students and 296 doctorates in the higher educational institutions in Estonia in 1993. In the 1990s a number of new specialities were introduced in the Estonian universities, for instance, commercial, business and public administration, religion and theology, mass communication and documentation.

The total number of post-graduate students (level categories 7 and 8) in 1993/94 was 2.8 times higher than in 1985. The admittance of post-graduate students in 1994/95 was 5.1 times as high as in 1988. It seems a good sign for the future of Estonian science.

The greater part of postgraduate students, category 7, studied in 1994 in the fields of social sciences and humanities (56.6%). Medical sciences attracted most of the doctoral students - 28.9%. 28.4% of students were engaged in the field of natural sciences, 20.9% in social sciences and the humanities.

Their age-distribution (Table 10) sets us grave: about 60% of master-students and 94% of doctoral-students were more than 25 years old in 1994. The main bulk of master-students (38.1%) and doctoral-students as well (41.2%) are in the age group of 25-29 years. It means, that the main part of researchers with academic degree begin their self-dependent life in science at the age of 30 years or even later.

Figure 8



The number of Candidates and Doctors of sciences engaged in the research institutions of Estonia began to diminish during the last years of Soviet occupation (Figure 8).

In 1994, the greater part of degree-holders (31.5%) worked in the field of natural sciences, 18.3% in engineering, 16.5% in social sciences. The distribution between other 3 fields was almost even (10-12%).

Table 10

Age-distribution of postgraduate students in 1994

Age in years	Master's degree (level category 7)		Doctor's degree (level category 8)		Total	
				F		F
21 and younger	29	14	-	-	29	14
22	187	72	1	1	188	73
23	300	138	2	2	302	140
24	244	113	19	10	263	123
25-29	734	298	160	60	894	366
30-34	258	118	110	35	368	153
35 and older	174	111	96	49	270	160
Total	1 926	864	388	157	2 314	1 029

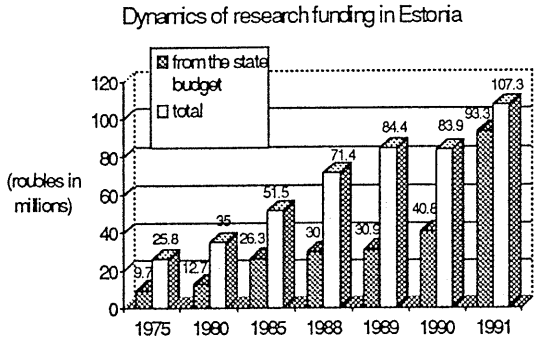
The percentage of degree-holders from total number of researchers is almost the same in 1985 and 1993 - 45.9 and 45.1 correspondingly. In Lithuania their share has increased from 37.9% to 55.2%, in Latvia from 38.1% to 115.6% (!). It seems that the last percent reflects the total number of degree-holders living in this republic, but the number of researchers enfolds only those engaged in active research. For Czech Republic and Slovakia the shares of degree holders were much lower in 1993 -20.6 and 26.1%, for Bulgaria - 44.0%.

The conclusion is that by formal qualification the potential of the research staff in the Baltic States is high.

1.3.3. The Reform of the Science Funding System

The Estonian Government, appointed in 1990, laid down the policy of creating foundations. The foundations had to provide funds for target research and development works according to the decisions made by their councils on the basis of peer review results and expert opinions.
In 1990 the Estonian Science Foundation (ESF) was established and the ESF Council (15-17 members) was appointed by the government. 7 (now 8) members of the council were elected as the heads of the expert commissions by the representatives of 7 fields of science.

Figure 9

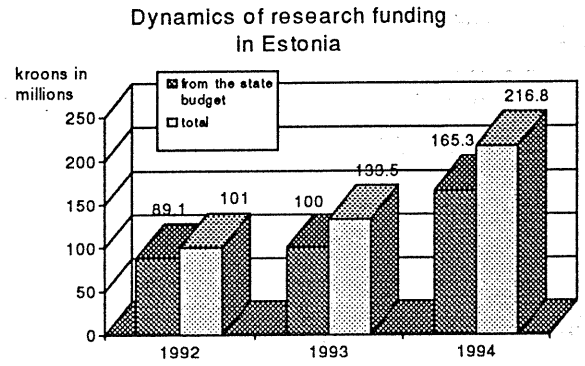


The first and most important task of the ESF Council was to change the paradigm of maintaining the research institution into supporting the project-groups and individual researchers. Parallel to this another tactical question arose - whether to introduce the project financing system all at once or gradually. It was clear that to avoid breaking off the continuity of research, as well as too sudden and frequent changes in the directions and priorities of research (especially in unstable economic conditions) it was necessary to maintain

the existing research establishment. It was decided that in the transition period the institutions engaged in fundamental research must be guaranteed certain basic funds. At the same time the practice of grant-awarding should gradually be developed. Since 1993, the percentage of grants in total funding has increased with every year reaching 28% in 1995.

Another problem which arose in the first years was whether to allocate the basic financing to every research institution directly or to distribute it between the "umbrella organisations" - the universities, ministries and the Academy of Sciences. The ESF Council decided to deliver the money between "the systems" just to have one more level of competence. It was decided to increase the share for the universities year by year to contribute to the integration of research and university education.
A minor part (4-5%) of ESF money has been distributed as single grants for special needs. These include: the publication of scientific journals and other serial publications, the money for spare parts and repair of expensive research equipment, the scientific collections, the communication networks (Internet).

Figure 10



One serious problem, awaiting solution on the government level concerns the top priority research fields which have not yet been indicated in a national perspective. The government is still gaining momentum to work out comprehensive R&D as well as educational, industrial, agricultural, social, healthcare etc. policies.

The dynamics of research funding in Estonia during the last 15 years of the "rouble-period" is illustrated by Figure 9. The dynamics of financing of Estonian science from the Estonian state budget appropriations in the period of the Estonian kroon (Ekr) is given in Figure 10 and Table 11.

In 1992-95 the absolute sum of money allocated to research in the state budget has grown more than 30% every year. But this growth has been slower than that of GDP. Comparison of the expenditure on research from the state budget as a percentage of GDP in Estonia with some other countries shows, that the situation is much the same in Latvia (1994 - 0.35%) and Lithuania (1991 - 0.29%)

Table 11

State budget financing of research in Estonia in 1992-1995 (million kroons)*

	Total amount	Growth, as compared to the previous year	%	% of GDP	% of the total expenditure
1992	60 840.00			0.40	2.10
1993	92 959.00	+32 119.0	52.8	0.40	2.26
1994	125 912.90	+32 953.9	35.4	0.44	1.78
1995 (planned)	166 870.00	+40 967.1	35.5	0.37	1.92

* The data for 1993-1995 is from the state budget of Estonia. For 1992 - from the "Statistical Yearbook" 1993. Statistical Office of Estonia, 1993. p.254.

As a matter of fact, if we add to the budget funding of research in Estonia the "hidden" R&D money, foreseen in the budget for some ministries, the total amount of money for R&D and its percentage of GDP will be a little bit larger (about 0.5).

Table 11 shows that the percentage of research money both from the state budget expenditures and GDP has decreased in Estonia during the last 4 years. Compared to the previous year the proportional increase of research money has also decreased. These numbers confirm the indifference of government circles and policy makers towards R&D. And, what is even worse, at present time in the former socialist countries the business sphere does not need (applied) research and, consequently, its allocations to research are very modest.

The financial allocations to R&D from the state budget as a percent from the GDP in other East European countries exceed the indexes for the Baltic States: for Hungary it was 1.1% in 1992, for Poland - 0.6% in 1991, for Czech Republic - 1.03% in 1993.

For Estonia we cannot compare these data with the period of Soviet occupation, as statistics did not show the GDP until 1990. According to our calculations, based on the data of the Ministry of Finances research expenditure from the state budget of Estonia was 0.42% of the GDP in 1989 and 0.52% in 1990. Including other sources this indicator constituted 1.3% in 1989 and 1.1% in 1990.

The share of expenditures for science in the state budget has grown from 1.4% in 1985 to 1.6% in 1990 and 2.26% in 1993.

The greatest problem for Estonia and other former socialist countries is that the share of funds from the business sphere for research is several times less than in developed countries.

There is a more or less reliable published data available on science financing and the sources of financing in the period of the Estonian kroon (Ekr) for the years 1990-94 (Table 12). This data shows that in 1992-94 the share of money from business enterprises and non-profit organisations increased 13-18%, i.e. the real amount of financing the research institutions got in 1993 and 1994 exceeded the financing from the state budget through the ESF by 30.4 and 58.1%.

Table 12

Financing of research in Estonia by source of funds, %

Source	1990	1992	1993	1994
Government funds	48.6	88.1	74.9	76.3
Business enterprise sector	51.4	1.7	14.3	9.6
Non-profit organisation's funds		-	4.4	3.1
Institutions own funds		0.4	3.2	4.0
Funds from abroad		9.8	3.2	7.0
Total	100.0	100.0	100.0	100.0

Total financing in 1992 - 101 079 Ekr, in 1993 - 133 538 Ekr, in 1994 - 216 798 Ekr

This difference is caused by the fact that only a part of the institutions doing research is financed through the ESF. Some state institutions, such as museums, archives, wild-life preserves etc. get their finances via the ministries as the research is only a minor part of their activities.

It is worth to mention that until 1992 the "funds from abroad" were presumably mostly from Russia (previously the Soviet Union). Since 1993, the financing of research in

Estonia from western funds and aid-programs (ISF, EC and other) has grown from year to year, but there is no summary data on the total amount of this funding.

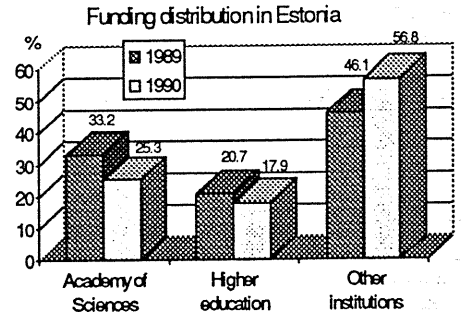
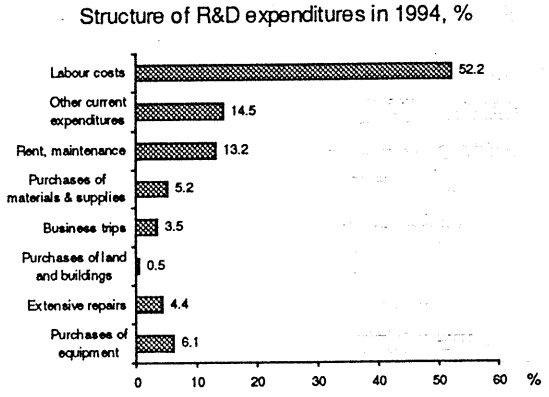


Figure 11 shows that the distribution of funding between the three main groups of research organisations changed in 1990-94. The share of money for the institutions doing basic research - the Academy of Sciences and the universities increased and the share of funds for non-academic institutions decreased.

Figure 12



The breakdown of R&D expenditures in Estonia in 1993 is presented on Figure 12. More than a half of all R&D expenditures is salaries and other costs associated with the personnel. Other operating costs (rent, heating, current supplies etc.) make up about 41%, the expenses on purchases of the equipment are very modest - total R&D expenditure 3.4%.

If we compare the R&D expenditure in some OECD countries (in 1989) and in Estonia (in 1993) per capita of population and labour force in USD (at the end of 1993 the exchange rate was 1 USD=13.8 Ekr) we get a most pessimistic result for Estonia (Table 13). R&D per capita expenditures in Estonia are 40-50 times less than in the Nordic countries. Even Portugal is in a far better position. In Europe we are comparable only with Turkey. There is no data available on the other Baltic States required for comparison.

Table 13

R&D expenditure in selected countries per capita of population and labour force

Country	R&D expenditure	
	per inhabitant, USD	per capita of labour force, USD
Denmark	224	399
Finland	271	520
Iceland	159	282
Norway	304	596
Sweden	428	829
Portugal	32	70
Turkey	6	18
Poland	46	-
Estonia	6.2	15.7

One more aspect: in 1990 the average salary was 340.7 SUR in Estonia and 392.1 SUR in the science sector. The corresponding numbers for 1993 were 1066.0 and only 960.5 Ekr respectively. It is not possible to calculate the average salaries in USD in rouble-period i.e. for the years 1985 and 1990, as the Soviet rouble was not

convertible. The exchange rate of Ekr on 31.12.1993 was 1 USD = 13.8776 Ekr. It means that the average salary in science sphere was 69.2 USD per month and 76.8 USD for the country.

It is very difficult to compare these numbers with the data for the other countries, one must hold in view that the "background" is much different in every former socialist country.

Table 14

Average Impact Factors and number of SCI publications in the Baltic States

		1986	1990	1991	1992	1993	1994
Estonia	Impact factor	0.789	1.140	1.381	1.331	1.590	1.654
	Number of SCI publications	226	239	239	260	243	302
Latvia	Impact factor	0.617	0.782	0.849	0.847	1.181	1.505
	Number of SCI publications	246	237	221	294	236	241
Lithuania	Impact factor	0.723	0.720	1.045	1.241	1.357	1.688
	Number of SCI publications	239	250	242	278	217	269

There is almost no summary data on the numbers of science publications and patents, as well as citations (by SCI) for Estonia. Some data on SCI publications in the Baltic States is given in Table 14.

During the period of Soviet occupation the intellectual property was protected by the USSR system of author's certificates and licenses. To copyright their inventions Estonian authors and inventors had to apply for the Soviet "Author Certificates". The inventors could apply for Western patents only after getting the "Author Certificate". From February 1994, Estonia is a member of the World Intellectual PropertyThis document by itself was for "inner use" only, it did not have any significance in the world context.

Organisation. In August 1994, Estonia reunited with the Paris Convention (Estonian Republic was its member from February 1924) and with the Patent Cooperation Treaty. The Estonian State Patent Department was founded in December 1991. From October 1992, the Patent Department started to accept the applications for registration of the trademarks, from May 1994 - the patent and useful model applications. Unfortunately Estonian enterprises and inventors have been rather inactive during the last years. By the year 1994 the number of patent applications in Estonia was only 482.

1.3.4.Concluding remarks

By the year 1995, a number of pivotal steps were completed in the course of science reform: the research councils set to work, the project financing on competitive basis and the new academic degrees introduced, the laws on science and universities passed in the Parliament. But still there is no concrete science policy [Martinson 1995]. The function of the Parliament is confined to drafting some (minimum) amount of money in the state budget for research. The Government's attitude has been mostly pragmatic: researchers must concentrate on current needs, on research supporting national economy and solving local problems as far as the basic research which demands large investments in equipment and supplies is not feasible for Estonia. On the other hand, the understanding that a state innovation system backed by state priority programs must be developed is immature as well.

The restructuring of industry has led to disintegration of large enterprises and to almost total absence of demand for science by the newly shaped enterprise sector. Consequently, the money for science from the business sector has been reduced to nought. It will slow down the process of transition from a mainly academy- and university-based science to a science-based technology and goal-oriented research science.

But the most alarming symptom is the growing indifference of the society towards education and science, the decline of appraisement of education and knowledge traditional for Estonian people during the last centuries.

There is a number of research groups in Estonia doing high level research in the fields of condensed matter physics, astrophysics, chemical physics, molecular biology and genetics, as well as geology, biochemistry and some other fields. It is proved by the greatest number of EC, ISF and other grants per capita in comparison with the other Eastern European countries, by comparatively high citation index and by electing our scientists members of international organisations. In 1993 more than 30 leading Estonian scientists were elected the members of international science organisations.

II METHODOLOGY OF SURVEY DATA

Estonia lacks comprehensive and systematic data about the science structures as in retrospective terms, as well as for the current period. The situation in statistics makes it very hard to evaluate the survey samples to any base. Keeping in mind the restricted funding and focused aims of the comparative study between the ten countries involved in the project, in the Estonian case it was decided to concentrate to those institutions and fields, which give the proportionately greatest contribution to the structure of science in Estonia. Two survey samples (referred to hereafter as REAL MIGRATION SURVEY and POTENTIAL MIGRATION SURVEY) concentrated on the research carried on in universities and institutes of Academy of Sciences, leaving aside the specialised research institutions under several ministries (in the medical, agricultural and industrial fields - comprising 13 percent of the total scientific personnel) and in wild-life preserves, museums and archives (6 percent). The research personnel in two universities (out of 6) selected for the project purposes for both surveys comprises 72 percent of the relevant personnel engaged in all universities, the selected academic institutes' personnel forms approximately the same proportion of the research personnel engaged in these institutes. The sampling procedure and the response rates are given in the following for both samples separately.

2.1. REAL MIGRATION SURVEY

The survey was carried out by the personnel responsible for the institutes' personnel department and the objective was to gather the individual level data for 1989-1994 of the research personnel having left the institutions during that period. In case of Tallinn only those were enlisted who had worked at the institute full-time, in Tartu University also those were enlisted who had worked at least more than one third of the time at the university. Altogether the data involves 1066 persons. Unfortunately for Tartu University it was impossible to get the background information of the persons having left and the collected information gives at most the overall picture by age, specialisation and year of leaving.

Estonia has covered in real migration survey two universities (the same as in the POTENTIAL MIGRATION SURVEY) and 9 Institutes of Academy of Science. All these institutions are represented in potential migration file, except one institute of Academy of Sciences (Institute of Language and Literature).

The data on real migration from Tartu University also lacks data for 1994. In the sample (originally 1200 names, including part-timers) were selected all those scientific workers who worked at least half-time, excluding all those who were found still working in other units of the university, 42 had died and 142 were born earlier than 1930 and did not have a degree. In the list remained 69 of whom 60 were non-scientific workers. Real migration data on Tartu University for 1989-1993 contains 405 of the remaining 609, the others were still found at the university.

In Tallinn, Tallinn Technical University data has additionally also included for 1994 all those who are enlisted in the university but for a whole semester freed for being abroad. That artificially increases for 1994 those being abroad. The data in the university contains 280 persons.

As the REAL MIGRATION SURVEY concentrated only on the exits of the research personnel, not taking into account the entries, the data cannot be used for estimations of the loss of research personnel. The science policy of Estonia during the transition period has taken the course to integrate basic research and education, not having been common to the Soviet structures. It has resulted in a turnover of research personnel between different scientific establishments, sometimes only involving the renaming of

one establishment into the structures of a university. In the end, universities might have gained due to the restructuring, which is not reflected in this dataset. Universities in general have lost research personnel only by 5 percent compared to 1990 level and the last years indicate that the scientific personnel is growing.

That is not the case for academic institutes, which are one of the main bases for restructuring and integrating fundamental research and education. In total the research personnel engaged in the academic system has reduced by 28 percent (in 1994) in comparison with 1990, however, the reduction process has also come to halt in academic institutions in last years.

For Institutes of Academy of Science the evaluation of data on those who have left the institutes can be made for 1989-1992 (by 1.01.90 up to 01.01.93). The evaluation reveals that the official data is very differently recorded and in some cases reflects only full time researchers, in others all have been enlisted.

According to that in 15 institutes, out of which 7 have been covered in real migration data file (3 institutes formed 1 institute before) by 1.01.1990 all scientific personnel encountered 1250, by 1.01.1993 there were 882 persons. During the mentioned period 486 persons had left (of those left in the frame of the same institute 32) and 118 were reengaged in these institutes, making the net reduction of 368 persons.

The official data gives the following reasons of leaving:

other academic institutes	36
other scientific institutes	18
universities	66
public administration	60
industry	5
private firms	90
abroad	47
retired	80
diseased	23
unemployed	15

In total left 337 of those who were the reference population for the survey (excl. pensioners and diseased), i.e. 26.96 per cent of the 1989 level. 35.61 percent were engaged in the internal brain exchange, proportionately more than half of those left to universities; 13.95 percent have left abroad, 4.45 are unemployed, 47.48 percent are engaged in non-science sphere (however, private firms which comprise two thirds in the subset might also have the scientific research). It has to be paid attention that due to the old age structure, common to Estonian population, the proportion of those retired is outstandingly high (more than 18 percent). Not having the retired persons in the REAL MIGRATION SURVEY sample has increased proportionately the share of younger research personnel among those who have left these establishments.

In the following the official data and the sample data for the institutes covered in real migration survey are compared for the years 1989-1993 :

	official data	sample data
Institute of Sociology, Law and Philosophy	8	12
Institute of History	24	16
Institute of Geology	19	29
Institute of Cybernetics	31	43
Institute of Economics	40	45
Institute of Language	24	20
Total	146	165

The sample covers more than half of the academic institutions, however the deviation from official data is notable and the collected data shows for 5.03 percent higher exit rate.

The sample on academic institutions is undersampled for natural sciences and significantly oversampled for social sciences in REAL MIGRATION SURVEY. In order to avoid the false interpretation, the analysis can focus only on general differences between universities and academic institutions, bearing in mind the overproportionate share of social sciences in the latter. Analysis by the fields has to restrict itself on the principal changes in the fields, not taking into account the type of establishment.

2.2. POTENTIAL MIGRATION SURVEY

The survey was carried out in the second half of April until the second half of June, 1995. The survey was carried out in two universities (Tartu University and Tallinn Technical University) out of 6 universities. They were chosen as the biggest and complementary to each other in profiles. Tartu University represents the bigger proportion of natural sciences together with social ones, as Tallinn Technical University represents the technical sciences . The third major site was the Academy of Sciences in Estonia which constitutes of 21 small institutes with the total number of research staff comprising 1103 by January 1994. As the institutes are small and in many cases the research staff altogether does not round up to 30, it was thought reasonable to deal with Academy of Sciences as a whole and pay attention only to the broad speciality in them. However, the sample was drawn from the lists of 15 institutes' research personnel by January 1994 and every third researcher was entered into the sample.

In total the sampling plan for the survey in Estonia consisted of 1112 scientists, of whom 700 answered the questionnaire, which makes the crude response rate for Estonia 0.63. The reasons for non-response comprised of the following categories: in all refused 84, dead were 3, 2 were ill, 1 on a maternity leave, abroad for the period of interview 31, had left the institute by the time of interview 22, working in another region 3.

In total not at risk being interviewed excluded 62 persons, leaving as the basis for response rate 1050 persons. Direct refusals comprised 8 per cent, which is somewhat higher than usually among the respondents (6-7 per cent). Non-response by not answering in time, losing questionnaires or being non-locatable formed 25.33 percent. The direct response rate formed 66.67 percent, being somewhat lower than other recently carried out surveys' response rates, however still in the framework of acceptable.

In Tallinn Technical University the list of scientific staff, including lecturers, included 750 names, out of which originally every second was chosen (325). After the first round, while 180 responses were gathered, additional sampling of 91 persons was made, out of which 64 responded.

In Tartu University every third was chosen (altogether got into work 376 names). 29 of them refused, 10 had left during the year, 121 did not answer to the questionnaire by the end of the schedule.

By institutions the results are the following:
1 Tartu University=376, returned questionnaires 216
Crude Repsonse Rate (CRR) 0.57, Refusal Rate 0.08
2 Tallinn Technical University 325+91=416, returned questionnaires 244
CRR 0.59, RR 0.11, Abroad Rate 0.04

3 Academy of Sciences.236+84=320, in total returned questionnaires 238
CRR 0.70, RR 0.05, AR 0.04

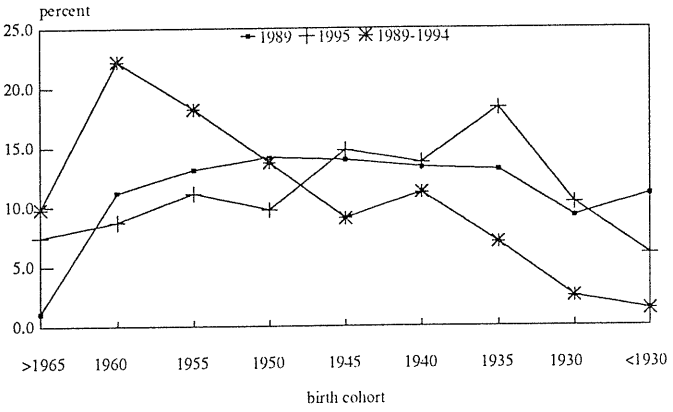
Academy of Sciences included the following 15 institutes:
Institutes of Cybernetics, Chemistry, Geology, Energy, Ecology, Sea, Economics, International and Social Studies, History, Biophysics, Biology, Astrophysics, Physics, Zoology and Estonian Biocentre.

In order to maintain the proportionate sampling between universities and academic institutions by oversampling one of them (Tallinn Technical University) has led to oversampling engineer-technical field, which has to be borne in mind while analysing the data. The significant non-response rate in the universities, especially in Tartu University, has led to some extent of undersampling the proportion of universities in the survey (60.7 percent compared to 68 percent in the sample plan). At the same time the sampling of academic institutions due to the focused aims of the comparative survey left aside some institutions in the field of humanities. As Estonia differs by the share of these fields in the total structure of science significantly from other countries under investigation, it has led to undersampling of the social sciences in broad terms (together with humanities). The significant proportion of natural sciences, common to all Baltic states, is representatively reflected in the sample of POTENTIAL MIGRATION SURVEY.

III REAL MIGRATION OF SCIENTISTS OF ESTONIA, 1989-1994

During the transition period the research personnel of Estonia has decreased around 29 percent, which mainly has affected academic institutions due to the principal reform of it and restructuring of the old system. The Baltic countries, especially Estonia and Latvia are characterised by an older age structure of the population in general, compared to all other East European countries. Due to the fact that the research personnel of Estonia in general is older and the focus of the current survey started out rather concentrating to the age groups, which are more exposed to the risk of emigration, the real migration survey did not consider those who have retired or died during the period (which forms approximately 20 percent of those who have left).

FIGURE 13. AGE STRUCTURE OF SCIENTISTS BY CENSUS, REAL AND POTENTIAL MIGRATION SURVEY, ESTONIA 1989-1995



The outcomes of the real migration survey, giving the overview of the exits of the research personnel over the period under study, have to be compared to the initial status in 1989 and the achieved status in 1995. Although Statistics of Estonia does not have scientific personnel related data by any details for 1989, the census carried out that year gives the approximation for the individuals' characteristics in 1989 (see Figure 13).

The intensity of leaving from scientific institutions has varied by years and countries under investigation. However, the distribution by years reflects the speed of reforms in the science, the initial year of transition period as well as the reaction to the concrete situation in the country. Table 1 reveals that East European countries had the peak of exits mostly in 1991, whereas peak-year for Estonia and Lithuania falls to 1992, Latvia having the latest peak in 1993. Although Estonia's data for 1994 is not representative (data from one university is missing), it corresponds to the situation in the country as a whole for the period. The peak of exits in 1992 for Estonia corresponds to the turning point in the country's development as a whole. That year the currency reform was introduced. It mainly affected those research areas which until then were still receiving part of the research funds from Russia, from then on they had to reorientate the research very rapidly. The evaluation of research projects by the Swedish Science Council came to its conclusions by early 1992, which again made several institutions think seriously over the future research projects.

Table 15

Distribution of the personnel by year of leaving the institute by countries

Country	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Total
Poland			134	133	202	249	293	168	157	8	1344
in percent			10.0	9.9	15.0	18.5	21.8	12.5	11.7	0.6	100
Czech				20	53	121	82	72	53	6	407
Republic											
in percent				4.9	13.0	29.7	20.1	17.7	13.0	1.5	100
Latvia			40	44	70	94	142	211	98		699
in percent			5.7	6.3	10.0	13.4	20.3	30.2	14.0		100
Slovenia		1	3	5	9	12	9	5	6		50
in percent		2.0	6.0	10.0	18.0	24.0	18.0	10.0	12.0		100

Estonia				112	158	173	291	232	78	6	1050
in percent				10.7	15.0	16.5	27.7	22.1	7.4	0.6	100
Romania			110	74	353	380	386	303	329		1935
in percent			5.7	3.8	18.2	19.6	19.9	15.7	17.0		100
Slovakia				48	148	196	207	186	153		938
in percent				5.1	15.8	20.9	22.1	19.8	16.3		100
Lithuania			28	35	97	119	211	131	121	5	747
in percent			3.7	4.7	13.0	15.9	28.2	17.5	16.2	0.7	100
Bulgaria	1	3	384	426	632	1555	1299	795	804	81	5980
in percent	0.0	0.1	6.4	7.1	10.6	26.0	21.7	13.3	13.4	1.4	100
Total	1	4	699	897	1722	2899	2920	2103	1799	106	13150

Estonian Science Foundation, although gradually moving towards the restructuring of scientific institutions in order to integrate education and basic research, had introduced reduced funding for basic needs for the existing state institutions. By introducing gradually funding by grants for research-projects, Estonian Science Foundation has encouraged new research projects to spring up no matter their institutional belonging. On one hand, it has helped to speed up the reform process in science, but has also indicated where the research is not up to the standards. It has also to be borne in mind that 1992 was one of the severest years from the viewpoint of economical situation, with the level of salaries in science being lower than average, which also has had impact on the reduction of scientific personnel. One more feature common to the period was that some of the personnel had been engaged in the institutions only part-timely, by 1992 when institutions got basic funding only in the amount of 75 percent of their actual needs, that led to the reduction of the part-timers in the first case.

Although it was beyond the scope of the comparative surveys, Estonia also asked question about ethnicity. In real migration survey, the data showed that of those who have left, 19 percent were of Non-Estonian origin, having mostly been engaged in engineer-technical field (one university closed down one branch in it) and among the Non-Estonians the percentage of those emigrated constitutes 13.64 percent.

While analysing the distribution of those having left the scientific institutions during 1989-1994 by administrative position, the attention has to be paid to the different coding in the Estonian data. As institutions are little in Estonia and cannot be very hierarchical, the professional position of the persons was coded rather than their administrative one. The lowest position (5) corresponds to assistants, the overwhelming proportion falls to the third category, representing research fellows (in universities: assistant professors), only the first category can be regarded fully as the highest position in the administrative hierarchy, also corresponding to highest professional position (professor, leading research fellow etc.). Although the data is representative only for the scientific institutions in one town (one university is missing), the smallest share of those with the lowest position indicates that those who have left have in principal established themselves as research personnel. The data on the duration of working years at the institute reveals quite even distribution over the scale, pointing out that the less mobile have been those who have just started their working career at the institute (having worked less than 2 years) together with those who have been there for 6-9 years. However, proportionately to the structure of personnel at the institute the staff with the smallest working experience becomes still higher due to their lessening share in the entries into working force. Our neighbours - Latvia and Lithuania - together with Czech Republic show the greatest share (around one third) for those having worked longest at the institute, Estonia having one fourth in this group.

Restructuring and reforms in science sector have developed differently by broad scientific fields. In the case of Estonia, it seems that restructuring has gathered speed from the very start of the transition period, gaining momentum by 1992. Only natural

sciences have experienced the greatest reduction in 1993. Comparison with Latvia and Lithuania suggests that reforms have gathered their speed later in these countries, Latvia gaining momentum for reduction rather in 1993 and social sciences only in 1994 (Table 16).

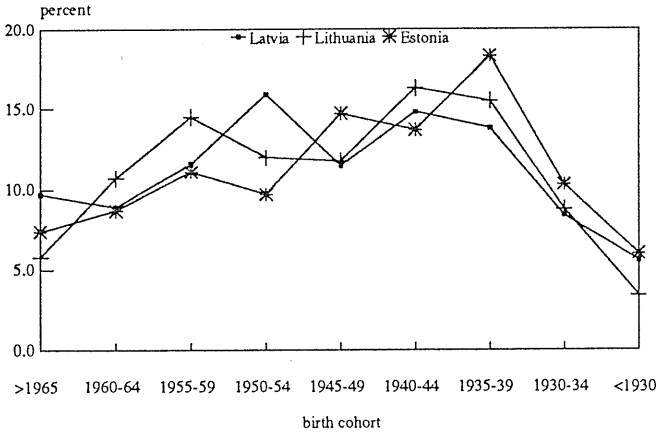
Table 16

Distribution of real migration by years and scientific fields

Scientific Field Country	1988	1989	1990	1991	1992	1993	1994	1995
Natural Sciences								
Latvia	5.8	10.0	13.1	14.8	21.6	23.7	11.0	
Estonia		11.5	13.3	15.9	18.7	35.7	4.6	0.3
Lithuania	5.3	2.7	14.2	12.9	24.0	20.9	19.1	0.9
Engineer-technical Sciences								
Latvia	5.4	1.9	7.6	11.4	20.2	39.4	14.2	
Estonia		11.3	13.3	12.8	34.5	11.3	14.8	2.0
Lithuania	3.1	3.6	8.8	13.0	45.6	13.5	12.4	
Social Sciences								
Latvia	6.6	9.9	8.8	16.5	16.5	18.7	23.1	
Estonia		9.8	17.0	18.4	31.2	17.0	6.4	0.2
Lithuania	3.0	6.7	14.6	19.8	21.0	17.4	16.5	0.9

3.1. AGE STRUCTURE

FIGURE 14. AGE STRUCTURE OF SCIENTISTS, BALTIC STATES POTENTIAL MIGRATION SURVEY, 1995

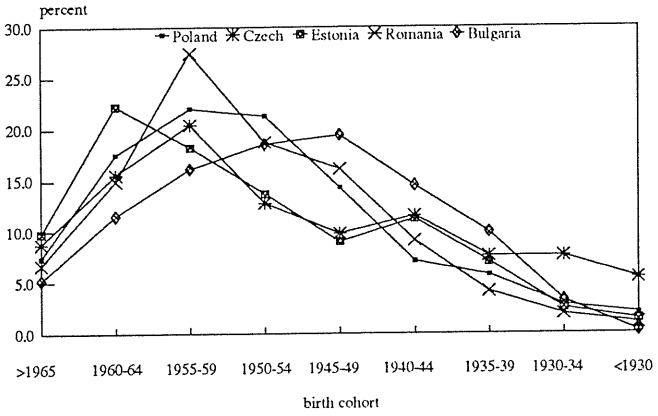


The transition period has had its impact on science sector as well as to other sectors. Science needed as much modernisation and restructuring as any other area while overcoming the inheritance of the totalitarian system. Part of the changes science is undergoing is thus of objective nature, part is the result of economic restrictions of the transition period , which does not give science any priority. The potential migration survey of scientists gives the overview of the research personnel's age structure by 1995. Figure 13 reveals the typical effect of the transition era on the age structure of research personnel: mostly the younger persons form the main gap among the personnel.

The problem of younger generation in science is not so much only that they are the most mobile and active part of researchers and so easily change their place of work, but also that the disproportionately low investment in the science sector during the transition period has hindered the new young generation from entering into the sector. If to look at the age distribution of scientists by 1995, in the case of Estonia the share of the youngest scientists (less than 30 years) is the highest among the Baltic countries, which might be one of the first indications of the recovery in this sector (Figure 14). However, the age structure of Estonia's scientific personnel is far from stabilisation and the intensive reduction of personnel during the 6 years has caused serious disproportions in the age groups, the most significant outcome compared to all other

disproportions in the age groups, the most significant outcome compared to all other countries being the greatest share of aged personnel in Estonia's science, despite the great proportion of those having retired during the period. The only country which seems to have overcome the effects of a transition period in science sector seems to be Hungary showing the normal, stabile age structure .

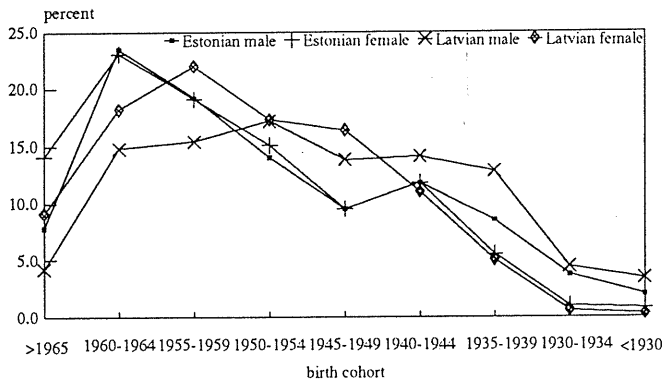
FIGURE 15. AGE STRUCTURE OF SCIENTISTS
REAL MIGRATION SURVEY, 1989-1995



Data from real migration survey in general supports the evidence from the current data. During 1989-1994 among those who have exited from scientific establishments in Estonia the greatest proportion falls to the cohort born in 1960-1964. Estonian age structure of those investigated differs significantly from other countries' comparative structures (Figure 15).

In most of the other countries the greatest share falls to the next cohorts (born in 1955-1959 and 1950-1954). Czech Republic shows somewhat similar to Estonia pattern of the age structure of those having exited from science, having another peak falling to the cohort born in 1940-1944. The upper slope of the older cohorts in Czech suggests that the sampling has included also the retired.

FIGURE 16. AGE STRUCTURE OF SCIENTISTS
HAVING LEFT RESEARCH INSTITUTIONS BY SEX, 1989-1995
REAL MIGRATION SURVEY, ESTONIA

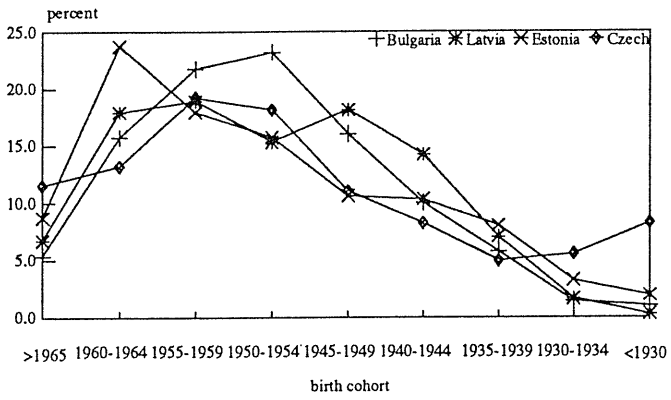


Another specificity of Estonia which is revealed in the real migration survey is the little differences between sexes exiting from science (Figure 16).

Estonian females contribute to the high proportion of the youngest cohort's exit from science, while males are more likely to contribute to the older cohorts, but in the most active ages the patterns are practically identical. However, as scientific personnel in Estonia is more the area of males (39 percent are female scientists in 1994 in universities and academic institutions), the outcomes of the real migration survey suggest in general somewhat higher intensity among the women leaving the institutions. Comparison with other countries has to be made taking into account the proportionate sex distribution among the scientific personnel in general. In most countries under investigation the females contribute much more to the exiting cohorts than male.

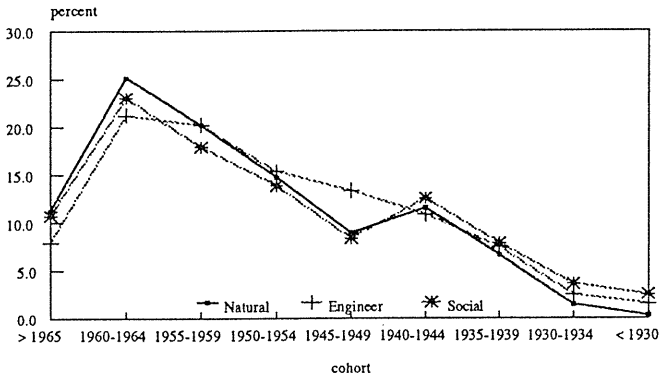
Estonia had in the real migration survey sample only two types of scientific establishments: universities and academic institutes, which form 85 percent of all scientific establishments.

FIGURE 17. AGE STRUCTURE OF SCIENTISTS HAVING LEFT ACADEMIC INSTITUTIONS, SELECTED COUNTRIES REAL MIGRATION SURVEY, 1989-1995



Due to the little amount of personnel in other institutions like state research institutes and private research institutions, these were not included in the sample. As the other countries due to their proportionately larger population could include the variety of other establishments, the comparison between countries for Estonia is not possible. However, as much as it can be followed from the data, the type of establishment from the viewpoint of age structure of the exiting personnel does not play significant role. Both establishments follow the general pattern in Estonia, universities are the main contributors to the greater share of those born in 1940-1944 for the exiting personnel.

FIGURE 18. AGE STRUCTURE BY SCIENTIFIC FIELDS REAL MIGRATION SURVEY, ESTONIA



The age pattern of those having exited from science by the broad scientific fields in general follows the overall pattern in Estonia. However, while natural sciences contribute to the younger cohorts, social sciences take over for the older ones. Somewhat different age pattern is revealed for those having been engaged in engineer-technical field: although the greatest proportion form those born in 1960-1964 they have a shift towards more elderly cohorts until the cohort born in 1940-1944 (Figure 18).

3.2. REASONS OF LEAVING SCIENTIFIC INSTITUTIONS

In order to understand the Estonia's specific age structure of those having exited from the scientific establishments during 1989-1995, one has to look where they have gone. Real migration survey tried to investigate into the subsequent working place but not always was it possible to derive the information. Estonia does not have the data according to the following working place for most cases from one university. Table 17 gives the overview where the personnel has left.

The principal differences between countries are revealed by these reasons. Firstly, Estonia differs significantly from all other countries by the proportion involved in exchange of personnel between the scientific establishments (Table 17). Estonia has the greatest share of those who have left for another state (whether academy or university) research institute in the country, thus again reflecting the general science policy trend in Estonia to integrate higher educational establishments with academic research institutions. It also explains why the personnel having left from science in Estonia appeared to have significantly lower proportion of those having no specific professional position. Secondly, the overall liberalisation policy of Estonia, especially in 1992 and 1993, has led to springing up research institutions on private initiatives whether non-governmental or private sector. This altogether means that science in

Estonia is efficiently restructured and those who have left from scientific institutions under investigation have not left science. In total science has gained almost 60 percent of those who have been studied. This is clearly the highest proportion having remained in science compared to all other countries, following to Estonia Slovak Republic (39 percent) and Czech Republic (34 percent) have already significantly lower proportions of this category. Although the category 'other' involves different areas in different countries, if to assume that all non-scientific activities, except involvement in public structures was included in that category, that also distinguishes Estonia with the second lowest level after Slovak Republic in these areas. Thirdly, Estonia is distinguished by one of the lowest levels of unemployed among the personnel who have left from scientific institutions. That corresponds to the overall policy of Estonia towards unemployment, where the benefits are kept at a very low level and in general the unemployment rates for Estonia are comparatively low even for the real unemployment (not only registered). Fourthly, even if to eliminate from the Estonia's sample those 14 who are still enlisted at a university but freed for a whole semester for being abroad, Estonia has quite big proportion of those who have left abroad (together with Poland, Romania and Lithuania). It suggests to look at those having left abroad more closely.

Table 17

Research personnel by directions of leaving during 1989-1994

	Left abroad	State re-search country	Non-govern-mental	Private reserch in country	Public adminis-tration	Public service	Un-emp-loyed	Other	Un-know n	Mis-sing
Poland	15.0	17.4	1.7	7.3	8.8	7.7	1.4	18.2		22.4
Czech R	3.4	11.5	5.2	17.7	15.5	3.2		21.4	11.8	10.3
Latvia	2.1	8.4	0.6	0.7	10.9	14.6	5.3	57.4		
Estonia	14.5	18.9	12.9	27.0	5.1	14.5	0.9	6.0	-	
Romania	17.0	16.3	7.3	2.5	8.8	8.4	2.2	33.2		4.4
Slovakia	11.3	16.2	2.6	20.6	10.7	8.3	2.3	5.5		22.5
Lithuania	13.4	16.3	2.7	3.9	13.1	3.2	3.3	22.9	19.8	1.3
Bulgaria	9.9	12.1	0.6	12.5	2.4	10.2	24.3	15.1		13.0

3.2.1. Scientific Personnel Having Left Abroad

In analysis of the contingent who has left abroad from the scientific institutions of Estonia the overrepresentation of the category for one university in 1994 has to be borne in mind (14 persons who in fact remain working at the university but had a free semester for being abroad). That has enlarged the share of the contingent for 1994. If to leave them aside, the share of those having left abroad constitutes 12.7 percent, with the peak falling to the year 1991, i.e. one year earlier than the peak turnover movement among scientific personnel in Estonia. Academic institutions as well as universities have both contributed to that contingent, academic ones proportionately more. As social sciences are overrepresented in the Estonian sample, they give the highest contribution to the contingent (39.4 percent), the next being natural sciences (38.4). There is no big differences for the contingent by sex, exception are the engineer-technical sciences, where women form only around 9 percent. If leaving abroad is mostly thought to involve single persons rather than married ones, Estonian data does not prove the point. Almost 70 percent of those having left abroad are married, however the tendency towards single persons is more vivid in natural sciences. However, those who have left from natural sciences for abroad are the youngest persons (with mean age around 31 years, compared to 39 to 40 years in social and engineer-technical sciences), which suggests that those leaving from natural sciences from Estonia are a different category. Although the sample does not give the length of working years at the institute for all persons, more than 30 percent of those having left

natural sciences have worked at the institute between 3-5 years, whereas in the group who have left social sciences more than 36 percent had worked less than 2 years. The latter finding seems somewhat surprising, but it reflects the turnover between universities and academic institutions, which had started already earlier. So, those who had left another institution just before the reforms where not yet integrated at the current institute's scientific work and thus more mobile. Engineer-technical sciences have lost mostly the people who have worked longest at the institute (36 percent more than 15 years).

Of those who have left abroad majority (almost 65 percent) are continuing their work in science, 18.7 percent are engaged abroad in non-scientific areas. However, the overall indicator for being engaged in scientific work also differs by scientific fields being the lowest for natural sciences (56 percent) and highest for engineer-technical sciences (more than 81 percent). The main contribution to the youngest cohorts' impact among the 'having left abroad' category is made by natural sciences, which mainly lose personnel from medicine, mathematics and geology. Although, in general, Estonia is characterised by one of the biggest shares of those who are being engaged in scientific work abroad (after Czech Republic), those in the cohort born 1960-64 and having come from natural sciences are the biggest contributors to the non-scientific employment abroad. The main areas engineer-technical sciences have lost are energy production and automation and data processing field. In social sciences economics, philology and scientific information have contributed to the category.

Estonia's scientific contacts fall mostly to the nearest neighbours - Scandinavian countries. Thus, more than 45 percent of those who have left abroad have gone to Scandinavian countries, after which follow with 20.9 percent USA, 12.8 percent Germany and 7.0 percent Russia. The Scandinavian countries have played more significant role for natural and engineer-technical sciences (correspondingly 59 and 57 percent), in social sciences USA is highly competitive with Scandinavian countries (26 and 29 percent respectively). Social sciences are also the biggest contributors to those who have left for Russia.

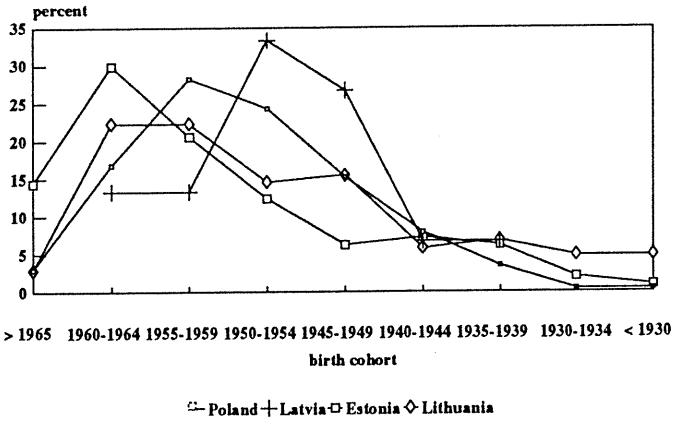
The structure of the scientific personnel having a degree of Candidate of Sciences (Ph.D.) or higher among those who have left is practically corresponding to the proportion in these institutions, however the biggest contributors to that are engineer-technical sciences. Among the latter 55 percent of those who have left abroad have a degree (Ph.D. or higher).

Among those who have left abroad only 23.8 percent did not have any specific position in the hierarchy of the scientific institution, 67 percent had been before that abroad for post-diploma studies (mostly in Scandinavia, Germany, UK and USA).

The age structure of those who have left abroad from Estonia very much differs from all other countries under investigation. Estonia together with Czech Republic and Slovenia has the lowest mean age of those who have left abroad. Slovenian sample engages only those who have left abroad. Estonia has the second highest proportion after Czech Republic of the youngest personnel (younger than 30 years) among those who have left abroad (Figure 19).

The next cohort (born in 1960-1964) exposes the main difference of Estonia from other countries. This cohort is the main contributor to the younger age structure of those who have left, including for abroad. The intensity of leaving abroad for the following cohorts is falling with every cohort, thus suggesting a different pattern for Estonia compared to other countries. Estonia distinguishes among other countries with the high proportion of those young cohorts having been in higher professional positions.

FIGURE 19. SCIENTISTS HAVING LEFT ABROAD DURING 1989-1994
REAL MIGRATION SURVEY, ESTONIA



Although younger cohorts are mostly involved in this category, it is not reflected in the accumulation of work experience in lesser years. Together with Czech Republic Estonia differs by the highest proportion engaged in scientific work while abroad. Czech Republic, Poland and Estonia are also distinguished by the highest proportions among them who have earlier had post-diploma studies abroad. This altogether suggests comparatively high proportion of Estonians having left abroad under the brain exchange category. For the youngest leavers it means also the opportunity to make their doctoral dissertations and work on joint projects. Although the main flow has been directed towards Scandinavian countries which means known environment, lesser language barriers to Estonians, quite high proportion of USA, Germany and United Kingdom suggest the variety of contacts. Estonians having left abroad seem to be a competitive personnel also by international standards. However, the young age structure and the early peak of this direction suggests that those who left went rather to gain from international knowledge during the science reform process in Estonia and are going gradually to come back to introduce their acquired knowledge into new developing structures.

3.2.2. Personnel Having Left For Science In The Country

The main specificity of Estonia seems to be the highest proportion of those who have left **from science for science**. As mentioned earlier, all those reasons which involve leaving for another scientific structure whether state, non-governmental or private, Estonia is distinguished from other countries with the highest proportions, altogether forming 58.8 percent of all reasons for leaving. It clearly reflects the general liberalisation policy of Estonia and efficient restructuring in the sphere of science having brought about springing up new forms of science organisation. Establishment of Estonian Science Foundation and introduction of grant system for science no matter which ownership form it is representing, has clearly contributed to this high proportion of having remained in science. The reduction of basic funds for state institutions, reduction of resources from ministries to branch-oriented scientific institutions have also been the forces for quicker restructuring in science as a whole.

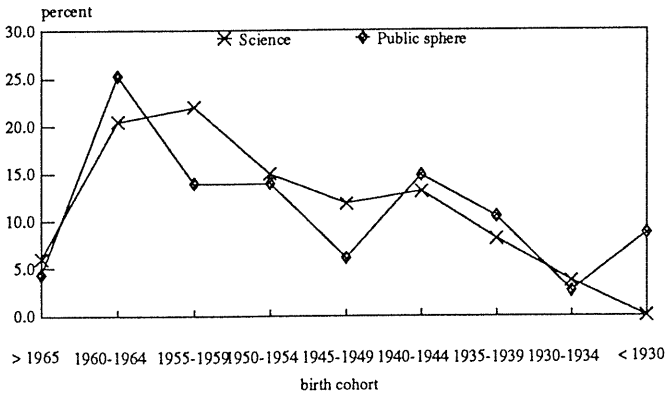
In general, those who have contributed to the turnover in the science in the country are comparatively older than those who had left abroad. Although, the proportions between institutions remain, women from universities tend to be more involved in the turnover compared to the average. The share of having a degree (Ph.D. or higher) is also proportionate to the average distribution, however, comparatively with those having left abroad tends to be a fraction lower (34 percent), engineer-technical sciences reflecting again their higher proportion with degrees (38 percent).

The structure of professional position reveals the proportionately low share of those having no specific position in the institute before leaving (23.3 percent), that being somewhat higher for those who have left from academic institutions.

Significantly this category differs from those who have left abroad by having a prior international contacts. In general, those who have been involved in the restructuring

process of science have had post-diploma studies abroad almost 4 times less (18 percent) than those who have left abroad. Natural sciences distinguish here with a very low 5 percent, social sciences having the highest proportion (26 percent). Those who come from academic institutions have almost twice higher probability to have had post-diploma studies abroad (23 percent, universities' personnel only 14 percent). The work experience in the previous institute is higher, showing the bigger proportions for those having worked for 10-14 years or more than 15 years, especially being more characteristic for those who have left from universities.

FIGURE 20. SCIENTISTS HAVING LEFT FOR SCIENCE AND PUBLIC SPHERE, 1989-1995 REAL MIGRATION SURVEY, ESTONIA



The age structure of those who have left for science in the country somewhat differs from those having left abroad, being lower in the youngest cohort but having similarly high peak for those born in 1960-1964 and 1955-1959 (Figure 20). Turnover of scientific personnel reveals another, although somewhat lower peak for the cohort born in 1940-1944. It has to be mentioned that the age structure differs very much whether the personnel has left for state, non-governmental or private research institution. The youngest have left for non-governmental structures, being with their age structure similar to those who have left abroad. Private research institutions contribute to the peak in cohort born in 1955-1959. The state research institutions gain from all age groups, except from the youngest ones, on the proportionately similar level. However, the second peak in the cohort born 1940-1944 in the age structure of the Estonia's real migration data is in fact due to those cohorts intensively exchanging for another state research establishment. Although somewhat less, but proportionately on the similar high level those born in 1935-1939 contribute to the turnover between state research institutions, i.e. the established scientific personnel is on move in science circles.

3.2.3. Personnel Having Left For Public Administration And Public Services

From the data of REAL MIGRATION SURVEY it seems that countries have differently coded leaving for public administration and public services. In Estonian case public administration meant high administrative position in public sphere, while public services meant different positions in public sphere. It seems that some countries have coded into public administration all positions in public sphere and left services alone in the category 'public services'. In Estonian case the public services was rather dealt with as the tertiary sector, bringing into 'public administration' only part of it (high administrative position). That suggests to deal with the mentioned categories together under the category 'public sphere'.

Leaving from scientific institutions for public sphere makes the second biggest volume of exits of scientific personnel after leaving for science in Estonia. The share of this category is the highest in Latvia, Estonia together with Czech and Slovak Republics are following Latvia with the share of the category among the reasons of leaving being relatively high (Estonia 19.6 percent).

Estonia having had proportionately the greater share of social sciences over time had also quite a good basis for losing the personnel for public sphere. Clearly, persons left from social sciences for public sphere one year earlier comparing to natural sciences. Those having been involved in academic institutions have the tendency to exit for that

reason earlier. Those who have went for public sphere are clearly the older of the three categories which we have reviewed in the paper more precisely. Those who have left from natural sciences have been younger (mean age 38 years, engineer-technical being the oldest with over 43 years). This is the sphere where women dominate, especially being characteristic for those exiting from social sciences. Those who have left for public sphere are to a greater proportion single (25.5 percent) compared to the first categories and with much higher proportion of divorced (8.2 percent). Although the share of leaving from academic institutions is comparatively larger than from universities, the latter is losing to public sphere mostly the single persons. This category also distinguishes from others by having the lowest proportion of those who have a degree of Ph.D. or higher (29.2 percent, being the lowest for social sciences 26.1). Social sciences have also lost for the public sphere the major part of those without specific professional position (57.5 percent compared to natural sciences 17.7, engineer-technical 16.6 percent). The engineer-technical field has lost personnel with the highest share of higher administrative positions comparative to other fields of science. The personnel having exited from academic institutions for this reason has the greatest share of those without specific professional position. The latter is also due to the higher proportion of social sciences represented in the sample of academic institutions. Those who have left for public sphere have the lowest share among them who have had post-diploma studies abroad (9.5 percent, with engineer-technical being the lowest with 6.7 percent). Academic institutions have higher proportion of those who have had post-diploma studies abroad even for this exiting category, which clearly indicates for better international contacts in academic institutions.

Natural sciences have lost quite a share of those who have less than 2 years or 3-5 years work experience at the institution (altogether 44 percent), while social and engineer-technical sciences are losing rather those with longer work experience (10-14 years and more than 15 years of experience constitute 60 percent among engineer-technical and 53 percent among those from social sciences). Those having exited for public sphere with longer work experience come proportionately more from academic institutions.

Those who have left for public administration follow the general age pattern having left from scientific institutions, being mainly from cohorts born in 1960-1964 and 1955-1959 (see Figure 21). Those having left for public administration also contribute to the higher share of the cohort born in 1940-1944. Although the main exiting cohort born in 1960-1964 is also contributing to those having exited for public services, the latter category distinguishes from other spheres by higher shares in older cohorts and the highest proportion who are born earlier than 1930, i.e. in retirement age. Public sphere is mainly gaining from those who have lost the possibility to move in science sphere, thus it is more characterised by personnel being older, having the lowest proportion with degrees and the greatest share without specific positions.

3.3. CONCLUSIONS FROM REAL MIGRATION SURVEY

Real migration survey proves that during the transition period the field of science has experienced intensive personnel's mobility. Behind the intensive mobility lies the objective restructuring process in Estonia focused mainly to uniting basic research and higher education. That is certainly reflected by the higher exit rate from academic institutes compared to universities. Data from official statistics for 1994 indicates that this process is coming to its end. Another relevant feature of the transition period is the springing up of new scientific structures on non-governmental or private initiative. Estonia distinguishes among all countries under investigation by the greatest proportion (58.8) who have left for another scientific institution, especially non-governmental and private institutions gaining their significant share in the science restructuring process. The latter once more indicates to the effective liberalisation policy typical to Estonia in general in its transition towards market economy, which

has enabled new structures to develop in relatively short period. Reorientation of funding system from totally state budget-orientation to research project-oriented grant system has laid the grounds for continuation of research no matter its institutional ownership. As conclusion it might be revealed that no matter the very restricted funding of science (allocations for science form the lowest proportion of GDP among the countries under investigation) during the transition period (or maybe exactly because of that) it has not produced the flight from science, but rather helped to restructure science in a more efficient and quick way.

However, the significant proportion of those who have left during the transition period to a foreign country has to be paid attention to. Estonia stands third after Romania and Poland by the share of the scientific personnel having left abroad and fourth if to reduce the share by the deliberately included sample of those who were during the survey period residing in the foreign country for at least half a year (14.1 percent of the category 'having left abroad'). Among those who have left abroad almost 65 percent are continuing their scientific work, being remarkably high for engineer-technical sciences (81 percent). The latter have proportionately more contributed to this category with a greater share of those being older, with longer work experience and higher proportion having Ph.D. or higher degree. The youngest have left natural sciences, among whom the share of those who is engaged in non-scientific work is also proportionately the greatest. Almost half of those who have left are engaged in neighbouring Scandinavian countries, which are very close and similar environment to Estonia. Whether this phenomena for Estonia means brain drain or rather brain exchange is hard to decide on this data, however the intensive international contacts of different fields of science, which is brought out for 1994, where oversampled temporary 'foreigners' from one university comprise almost half of all the category for the year, indicates rather towards exchange phenomenon.

Transition period has clearly brought about the effect that science has lost to public sphere those who have not established themselves as scientists: this category is characterised by the lesser frequency of international contacts, greatest proportion without any specific research position, lesser proportion among them with Ph.D. and higher degree. Partly this is the response to the reduction of basic funding.

Thus the main conclusion from real migration survey is that Estonia is characterised by the big turnover of 30-34 year old scientists who have not yet thoroughly established in their research environment and thus actively mobile between new emerging structures of science. The peak of Estonian scientific personnel's exit comes to the younger cohort than all other countries under investigation, the same cohort contributes mainly also to those leaving abroad. Somewhat older and more experienced research staff is mainly contributing to the restructuring process between academic institutes and higher education establishments. The survey has also brought out one of the most steady age groups which in Estonia seems to carry the scientific continuity - these are 45-49 years old researchers, who are less mobile of all age groups.

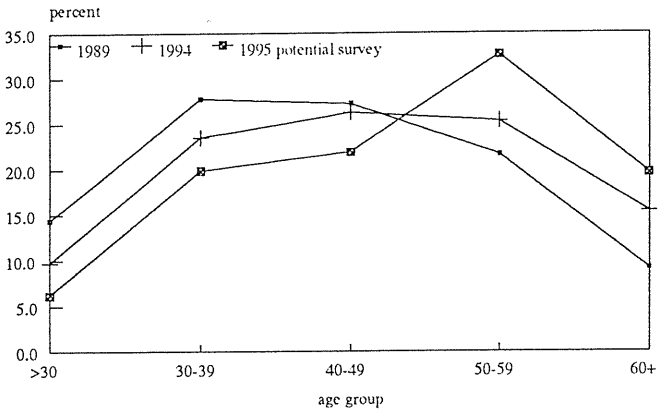
Science is reflecting the general trends of transition period:
(1) intensive mobility in seek for better and new opportunities, which can be evaluated positively from the viewpoint of reflecting quick restructuring process
(2) intensity of mobility falls to the most active, but scientifically not yet established part of personnel, which on one hand helps to build up effectively new structures in the country, but if their leaving abroad becomes not only the effect of transitional period during which to gain from international knowledge and in due time to apply it in the domestic fields of science, 13 percent of scientific personnel has to be regarded as being lost due to international brain drain.
(3) restricted economic situation has reduced scientifically not established personnel with older age structure but lesser qualification

(4) almost 30 percent reduction of scientific personnel has brought certain gaps in the age structure, thus indicating to the arising problem of discontinuity for some fields. The most stabile cohort in Estonia in science are 45-49 years old scientists.
(5) proportionately the lowest allocation of resources to science in Estonia compared to other countries has contributed to the ageing of the scientific personnel to a great extent and if continuing is producing the discontinuity of generations involved in science by the most active personnel leaving and new generation not entering. The latter is the worst impact to science of Estonia, which in this case can lose all the effects of the so far quick and efficient transition.

IV POTENTIAL MIGRATION OF SCIENTISTS

The potential migration survey tried to represent the current structure of scientists as closely as possible. However, the survey has some deterioration from the overall structure of the scientific personnel by the official statistics. Although the official statistics also does not cover all newly emerged structures, it must be assumed that by the main structures - universities and academic institutions - it is representative. The representativeness problem is more thoroughly discussed in the part *Methodology of Survey Data*, here we want to stress the underrepresentation of younger cohorts and overrepresentation of older cohorts in the Estonian survey data, which has to be borne in mind, while analysing it. Figure 21 gives the overview about the age structure by the potential migration and real migration survey and the age structures of the scientific personnel by 1989 and 1994 by ten year age groups.

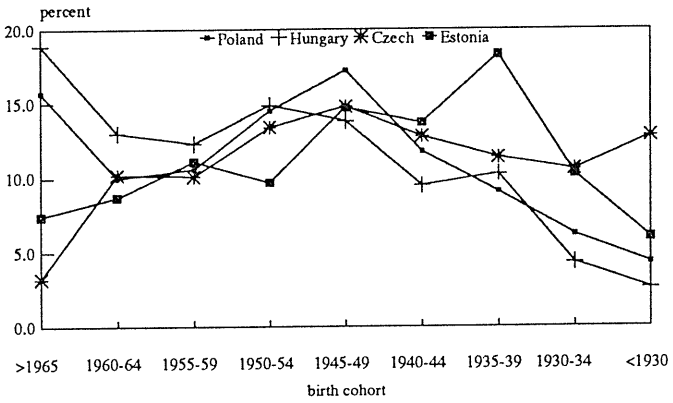
FIGURE 21. AGE STRUCTURE OF SCIENTIFIC PERSONNEL ESTONIA, 1989 AND 1994



The ageing of the scientific personnel over the transition period is visible. Although exits of scientists have mainly fallen to the age group 30-34, the transition period has produced the greatest reduction for the youngest age group - under the age 30, which has been reduced by one third. This is the main effect of the period, which has not so much resulted from the effect of scientists' leaving the research as more from processes preventing them to enter in this field of activity. On one hand, it is understandable, because the transition period opens up the whole variety of opportunities for those who have graduated from higher educational establishments. Higher education is evaluated in a much broader scale of activities than earlier. Besides, the principal restructuring of science has not resulted in the relevant level of funding which would indicate for the younger generation engagement in science as one of the alternative perspectives. It is less apparent for those who have already chosen science as one of the life perspectives and thus, as it came out already from the real migration survey of Estonia, the majority who have left from science in older ages have to a great extent contributed to the restructuring in science itself rather than leaving it for other fields of activities. Inevitably the process of younger cohorts not entering into science has led to even more significant ageing of the scientific personnel than it would be with the same age structure but stabile society. The ageing of the scientific personnel is caused by the situation that research tasks have to be fulfilled and there certainly is some critical amount which is needed to carry these tasks out.

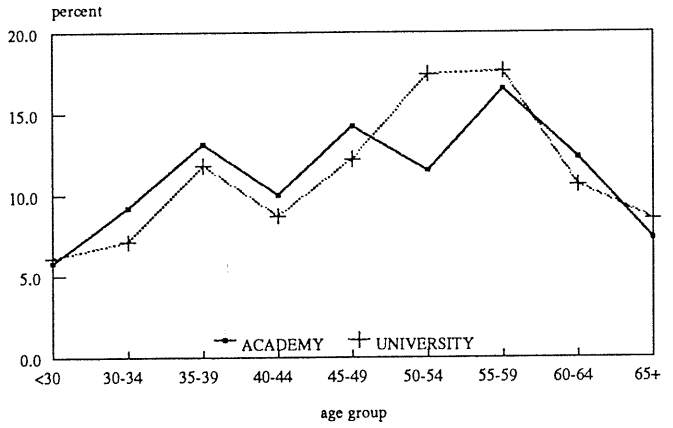
However, in the range of the countries under investigation, the share of the youngest cohort among all scientists in Estonia is not one of the lowest. If to evaluate that the proportion of young scientists is one of the indicators of the restructuring speed and the rising proportion of the young scientists could be an indicator towards stabilisation, the countries could be divided into two main groups.

FIGURE 22. AGE STRUCTURE OF SCIENTISTS
POTENTIAL MIGRATION SURVEY, 1995



Estonia clearly belongs to the group of countries with the restructuring process undergoing in the society. In this group, Estonia holds the leading position. Stabilisation might be underway in Poland and Hungary (see Figure 22). By that indicator, Czech Republic and Slovenia have been considerably harmed by the transition period, because the inflow of younger scientists has not yet begun (otherwise, there is clearly a big underrepresentation and the data could not be analysed to the same degree as the other countries). Romania is distinguished by a high proportion of young scientists, however, it is thought that in that country the restructuring process has not yet begun in the same extent as in other countries.

FIGURE 23. SCIENTIFIC PERSONNEL BY RESEARCH INSTITUTIONS
POTENTIAL MIGRATION SURVEY, ESTONIA 1995



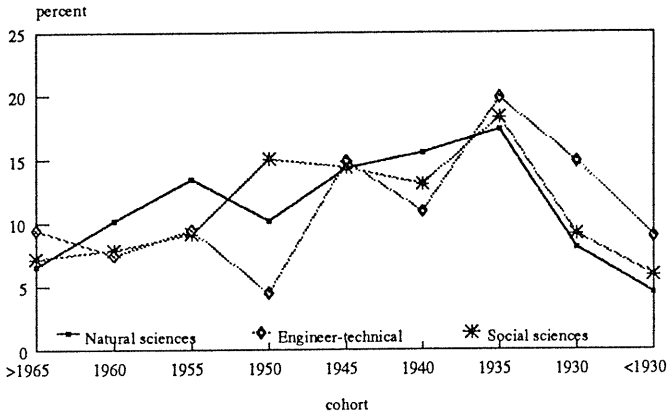
The process of restructuring science in Estonia has mainly involved shifting the research in the universities from applied research towards basic one, thus several research groups in previous academic institutes have been integrated into universities. As academic institutes were the main focus of reforms in the beginning of the transition period, it has resulted in proportionately more people retired and those who have not defined themselves as scientists more clearly to leave for other fields of activities, thus academic institutes are now characterised by relatively younger age structure. Universities have still a significant proportion of the personnel in pre-retirement age and the youngest cohorts entering into science in universities are not visible (Figure 23).

The research personnel in all countries is more male-oriented. In the Estonian sample the females are underrepresented in comparison to their actual share in the scientific personnel (1994 - 41.3 percent, in the sample 31.1). Share of females among the scientific personnel significantly reduces by achieving the retirement age and in comparison to male personnel is also lower in the age group 35-39.

Altogether, Estonian scientific personnel is distinguished by one of the highest mean ages (48.7) after Czech Republic (50.4); Latvia (47.1) and Lithuania (47.4) are following very closely. The engineer-technical fields are characterised by the oldest age structure, showing also the biggest discontinuity with the very low share in the age group 40-44. However, this field is characterised by the greatest share among the youngest ages, which might be the first sign of recession in the field. Natural sciences are in overall characterised by the lowest mean age (47.7) of the personnel engaged in the field and have not been exposed to dramatic discontinuities in the age structure. In social sciences age group 40-44 has clearly been most stabile oppositely to other fields. Social sciences have significantly reduced the share in the oldest age groups, thus

leaving engineer-technical field with the highest share among the age groups of retirement age (Figure 24).

FIGURE 24. AGE STRUCTURE BY SCIENTIFIC FIELDS
POTENTIAL MIGRATION SURVEY, ESTONIA, 1995



One of the main outcomes of the survey is the result that those who are working in state research establishments (whether academic or university) are with a very big length of work experience (more than 78 percent over 15 years of experience). If to keep in mind the overrepresentation of the older cohorts in the sample compared to the real situation among scientific personnel, this percentage might be lower for the whole scientific community, however, it underlines once more that science has not had recent inflow but only the established scientists have remained in science, which bears several consequences for the future developments in science.

In general, Estonian scientists look well in the surrounding of the East European countries. Estonia is by the amount of international articles per scientist on the second place after Hungary and by the amount of the conference papers on the third place, only by the amount of books per person Estonia stands in the middle of the countries under study. Engineer-technical sciences have contributed mostly to the articles, natural sciences to the conference papers and social sciences to the books in Estonia. In all these forms of scientific performance institutions of Academy of Sciences have contributed comparatively more, which once more brings forth the orientation of basic research in these institutes.

Table 18

Percentage of personnel who have international publications

Country	Articles	Books	Conference papers
Romania	42.3	10.2	48.6
Slovakia	45.3	22.0	69.4
Latvia	56.4	12.6	56.9
Poland	57.8	18.8	58.3
Lithuania	61.6	11.3	67.0
Bulgaria	66.3	9.9	62.4
Czech Republic	69.2	25.8	71.8
Slovenia	73.3	25.9	83.3
Estonia	80.0	20.7	72.9
Hungary	85.10	33.0	77.8

As to the international contacts they can be evaluated by two directions: visits of scientists in foreign countries and engagement in international joint projects.

The proportion of scientists having had foreign contacts is clearly very high in Estonia. Among those who have had any traineeship or fellowship abroad, Estonia is placed second after Czech Republic with more than 40 percent. Among the countries under study Estonia is on the third position by having been abroad because of joint international projects.

Table 19

Distribution of scientists having been abroad by countries and reasons

Country	Fellowship	Post-graduate	Ph.D. study	Joint project	Part-time job abroad
Poland	25.3	5.8	1.2	21.3	4.8
Hungary	22.0	9.0	1.8	37.5	6.9
Czech Republic	42.0	5.1	0.9	26.2	5.3
Latvia	25.4	5.7	0.2	9.0	2.0
Slovenia	36.6	8.3	5.1	19.3	4.6
Estonia	40.1	6.0	1.4	22.9	16.6
Romania	19.0	4.6	1.2	12.5	2.7
Slovakia	26.5	3.9	0.3	14.2	4.7
Lithuania	21.6	1.9	2.6	11.0	5.6
Bulgaria	24.8	8.0	2.1	20.0	2.5

However, Estonia distinguishes among all of them by almost every fifth scientist having a part-time job abroad. Estonian sample includes in the part-timer's category also those who have had short-term work in their speciality abroad, which explains the very high proportion of them compared to other countries. As in the Estonian questionnaire these two options followed each other the pure category of part-timer's involves 3.4 percent. That leads to the conclusion that the established scientists in Estonia are competing on the international market and offers the possibility to look at the high proportion in real migration survey of those having left abroad as long part-timers. The relative lack of young scientists is reflected in the comparatively low proportions of having been abroad for post-graduate studies or Ph. D studies. Most probably they are also partly constituting the category having left abroad in real migration survey - they are currently studying abroad and have not come back yet. It is also the general reflection of the trend of relatively older researchers forming the categories of post-graduate and doctorate students, described in the general overview of science place in the Estonian society.

Although the high proportion of part-timers is maybe the greatest surprise from the survey, while in the planning stage Hungary was thought to have the highest proportion of those, it is still quite understandable. If to look at the distribution by countries, the main share of all contacts falls to the neighbouring Finland. With the very similar language environment, short distance and not so different scientific environment, Finland is a target country for Estonia, which no other country does have. Still, although Finland is out of competition, for those having had fellowships abroad after other Scandinavian countries - Sweden and Denmark - follow Germany and United Kingdom, the variety of contacts involving all, except Portugal and Switzerland. In the contacts which have involved joint research work more than half fall to Finland and Sweden, after which follow USA and Canada, Germany, United Kingdom, Denmark and France.

One would think that in the part-time jobs Finland would be overwhelmingly represented, but although Finland together with Sweden hold the first role, Germany and USA together with Canada are following them by quite a high share.

The competitiveness of the research environment can also be evaluated by the share of joint research projects among the scientific personnel. Although the reforms and transition of Estonia have started later than in East European countries, its environment has been brought into the international scientific framework very quickly. By the proportion of those who currently work on joint projects, Estonia (37.6%) comes fourth after Hungary (56.1%), Czech (43.0%) and Slovenia (41.4%).

4.1. POTENTIAL FOR EMIGRATION

The main aim of the surveys was to establish the impact of the transition period on the potential of scientific personnel and the main directions of the value orientation of the scientists. The potential migration survey started out from the hypotheses that transition has a significant effect on the potential of emigration among scientists due to the instability in the home countries. The other aim was to evaluate the direction and impact of possible internal mobility. In this chapter the potential of emigration among the Estonian scientists is going to be evaluated.

The potential of emigration can be evaluated from two angles: broad definition regards all who have expressed the wish to go abroad as the contingent being at risk, strict definition regards potential only in relation to concrete steps undertaken which indicate towards the possible realisation of the person's inner wish.

Table 20

Potential emigration by acceptance of an invitation to leave abroad for more than one year

Country	Base	Accept without hesitation	Accept under circumstances	Accept but postpone	Decline offer	Do not know
Bulgaria	963	42.6	38.1	4.7	10.7	3.4
Poland	1167	15.5	46.7	10.1	23.3	4.4
Czech R.	923	14.0	50.5	6.5	26.5	1.6
Latvia	610	16.4	41.3	9.2	25.7	7.4
Slovenia	639	17.1	54.6	6.6	18.9	1.9
Romania	1025	34.7	45.8	2.6	9.1	7.8
Slovakia	924	24.1	46.1	7.3	17.0	5.2
Lithuania	672	30.8	44.2	4.0	15.6	3.4
Hungary	723	12.3	48.8	14.2	19.8	4.8
Estonia	684	20.6	34.2	8.8	35.2	-

According to the potential migration survey the questions which tried to assess the willingness to leave the country for more than one year, Estonia is in the middle of the range of countries with the proportion of 20.6 who would accept the invitation without any hesitation. If to rank these countries by the length of transition period and the time elapsed from the opening of the society to international contacts, Estonia has the lowest proportion among the so-called late starters. Estonia distinguishes among all the countries under investigation by the greatest proportion of those who would decline such offer (35.2 percent). Thus, the overall potential for leaving the country by the latter indicator can be evaluated as low. The first indicator clearly bears the effect of transition period, but in general also tends to indicate towards a relatively lower potential than is characteristic to countries in comparable situation.

To differentiate the above-mentioned potential by more concrete reasons for accepting invitation to leave the country, the main flow has qualified themselves in other reasons. The other reasons in the case of Estonia proposed the short-term (up to 6 months) fellowship or research work, in which case 37.3 percent of the respondents would accept the invitation without hesitation and only 14.8 percent would decline the offer.

Table 21

Potential emigration by acceptance of invitation in case of:

		Fellowship		Research work		Non-research work		Other possibility	
Country	Base	will accept	will not accept	will accept	will not accept	will accept	will not accept	will accept	will not accept
Bulgaria	930	34.3	25.7	33.2	18.4	13.3	52.2	8.4	69.3
Poland	1164	10.9	39.8	10.3	35.7	4.8	64.5	2.6	76.2
Czech R.	904	10.7	35.8	10.8	35.0	3.8	64.8	6.2	52.7
Latvia	610	12.3	41.8	11.1	52.8	2.8	82.0	2.0	88.5
Slovenia	616	11.4	38.1	10.7	27.3	3.4	61.3	3.1	74.7
Romania	1025	26.6	27.9	24.7	23.1	10.5	46.8	7.9	66.2
Slovakia	915	18.5	33.8	17.4	32.0	9.3	49.8	3.4	70.2
Lithuania	634	23.7	28.7	20.0	29.0	9.6	58.4	7.6	69.8
Hungary	716	9.2	32.0	9.6	27.7	3.9	66.4	3.4	83.5
Estonia	673	13.7	44.4	15.3	40.2	2.2	79.9	37.3	14.8

The lowest proportion among those who would accept the non-research work without hesitance once more indicates to the very self-determined research personnel in Estonia. In general this indicator can be to some extent also regarded as a criterion for the restructuring process.

Relatively low proportions of those who would accept fellowship or research work abroad for a year is also to some extent related to the duration of transition period and earlier intensity of international contacts, thus exhausting this potential.

Table 22

Potential emigration by arrangements made for departure

Country	Base	Yes, I am arranging my departure	Yes, but I have not undertaken specific steps	Yes, but not know	No, I do not intend
Bulgaria	955	2.9	17.8	18.8	60.5
Poland	1167	2.1	6.5	17.2	74.1
Czech R.	915	4.4	9.4	18.2	68.0
Latvia	610	1.5	8.0	6.9	83.6
Slovenia	636	3.3	10.5	14.0	72.2
Romania	1025	2.6	31.0	12.4	54.0
Slovakia	927	4.4	14.6	11.7	69.3
Lithuania	698	0.7	6.4	15.8	77.1
Hungary	720	6.3	11.0	13.1	69.7
Estonia	686	1.9	5.7	12.2	80.2

The level of the potential for emigration by the strict definition reduces the volumes significantly. Estonia together with Latvia and Lithuania are clearly distinguished among all other countries by a very low potential for emigration among scientists in these three countries, which is mainly represented by the highest shares of those who do not intend to leave for a foreign country at all. Under the highest risk of realising their intention are those who are already arranging the departure. All Baltic countries show the lowest share among the investigated countries, Estonia among the mentioned three with the highest 1.9 percent. At the second level, which involves greater flexibility of the intention, Estonian research personnel demonstrates the lowest share.

Among those who are thinking of leaving for more than one year but not intending to do it in the near future, the shares for the scientists in Baltic countries are also the lowest. Only data of Slovak scientists is showing after Latvia the lowest proportion for this category.

Among the category who is thinking of leaving abroad, Hungary and Estonia distinguish by the biggest proportion of those who are trying to envisage continuing their work at the research organisations (whether training or research organisations).

Although in its major (more than 80 percent) part this category intends to leave only for a shorter period (from one to three years), Bulgaria and Romania come forth with the highest proportion of those who would stay forever. Although with the overall lowest share of the category in general, next follow the mentioned countries by the proportion of remainers abroad forever Estonia and Latvia.

Among those who are going to leave abroad for more than one year mainly dominate West European countries. For Estonia, the Scandinavian countries domination makes the proportion of West European countries the highest. Estonia is also distinguished by the biggest proportion among all countries of the share of East European countries as the possible directions of emigration. In the data of Estonia, Russia as one of the directions was coded under the category of East European countries.

The funding of potential migrants is to the great extent in all countries falling mainly to the receiving institutes (around 80 percent), except Latvia and Slovakia with much lower share. Estonia distinguishes among all countries by the lowest shares in local funding - as by the present institute as well as the domestic organisations. After Hungary and Czech Republic Estonia is having also one of the lowest share of own expenses as the source for leaving abroad for more than one year.

Most significant for those intending to leave abroad for more than one year in Estonia is that the greatest proportion have turned to the domestic institutions among those who have taken any steps (52.9 percent), which in the case of Estonia mainly meant looking for possibilities of self-development abroad by traineeships or fellowships. Together with the described steps, looking for assistance from foreign colleagues correlates highly (comprising 43.4 percent) with the above-mentioned category.

Those who are arranging their departure abroad are significantly younger compared to those who intend to stay. In Estonia natural sciences are having the potential to lose the youngest for foreign countries, however the greatest proportion are going to lose social sciences, while natural sciences are going to lose comparatively least firm migrants of the three fields. To the great extent those who are arranging their departure come from universities. There are not big differences by having degree- as they are younger, the greater proportion represents those who have only university diploma or Master's degree.

By the results of the two surveys carried out it can be evaluated that academic institutions have had better opportunities to have international contacts over time, basically due to their stronger research orientation. Thus, those who are now arranging their departure are showing the shift towards universities, which means realising the opening opportunities in training. Those who are arranging their departure abroad cannot be depicted as having had earlier more international contacts, although personnel from social sciences and academic institutions is clearly distinguished by having been abroad earlier more frequently. Those who are leaving from social sciences, approximately 60 percent have had earlier fellowships, 20 percent have been abroad in connection with joint research or have had a part-time job abroad. Engineer-technical field distinguishes among the potential leavers by practically not having been abroad earlier.

Table 23

Potential emigration by destination activities

Country	Base	Work at research organisation	Work at international organisation	Professional training	Work on joint research project	Work at non-scientific institution	Any research work	Any kind of work	Will not work (medic. treatment	Other
Bulgaria	373	44.0	1.9	3.5	13.9	3.5	27.0	5.4	-	0.8
Poland	275	42.2	2.2	23.6	14.9	2.9	6.2	3.3	1.1	3.6
Czech R.	284	35.9	5.3	23.6	19.7	3.9	4.6	2.8	1.8	2.5
Latvia	100	31.0	1.0	27.0	20.0	5.0	5.0	4.0	1.0	6.0
Slovenia	174	33.3	4.6	21.3	20.1	6.9	6.3	3.4	-	4.0
Romania	471	38.9	3.4	23.4	10.4	3.2	8.3	8.5	1.5	2.6
Slovakia	248	62.5	1.6	5.2	11.3	6.9	8.5	2.4	0.4	1.2
Lithuania	149	30.2	-	20.1	21.5	3.4	8.1	10.7	1.3	4.7
Hungary	195	59.0	1.0	3.1	33.3	0.5	2.1	0.5	0.5	-
Estonia	137	49.6	2.9	28.5	14.6	1.5	-	2.2	0.7	-

Table 24

Potential emigration by country of destination

Country	Bulgaria	Poland	Czech R.	Latvia	Slovenia	Romania	Slovakia	Lithuania	Hungary	Estonia
Base	375	265	289	99	169	471	265	153	213	129
West European countries	52.0	54.0	55.4	64.6	54.4	63.5	54.3	63.4	44.1	69.0
East European countries	1.3	-	-	-	-	0.2	3.8	3.3	-	4.7
USA	23.5	35.8	27.0	24.2	32.5	20.4	29.4	26.7	37.1	23.3
Canada	8.3	2.6	9.3	9.2	3.6	9.2	5.3	0.7	2.3	2.3
Japan	2.9	2.3	2.4	-	0.6	2.5	1.9	-	3.8	-
Other	12.0	5.3	5.9	2.0	8.9	4.2	5.3	5.9	12.7	0.8

Table 25

Potential emigration by steps undertaken

Country	Base	Reading advertisements		Looking for assistance		Informing relatives		Looking for employment agency		Addressing domestic institutions		Other preparation to stay abroad	
		Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Bulgaria	342	45.0	55.0	51.7	48.3	28.5	71.5	10.3	89.7	30.5	69.5	10.4	89.6
Poland	272												
Czech R.	301	27.6	72.4	46.2	53.8	23.3	76.7	6.0	94.0	17.3	82.7	14.3	85.7
Latvia	100	26.0	74.0	27.0	73.0	28.0	72.0	13.0	87.0	23.0	77.0	14.0	86.0
Slovenia	146	47.3	52.7	62.3	37.7	16.6	83.4	8.4	91.6	32.7	67.3	30.7	69.3
Romania	471	24.0	76.0	17.4	82.6	13.8	86.2	2.3	97.7	18.3	81.7	8.9	91.1
Slovakia	282	36.2	63.8	63.5	36.5	28.4	71.6	18.4	81.6	31.2	68.8	13.9	86.1
Lithuania	89	57.3	42.7	59.4	40.6	31.7	68.3	16.4	83.6	37.0	63.0	40.7	59.3
Hungary	194	23.3	76.7	48.9	51.1	12.0	88.0	2.3	97.7	27.8	72.2	26.6	73.4
Estonia	136	31.6	68.6	43.4	56.6	16.2	83.8	1.5	98.5	52.9	47.1	10.3	79.7

Table 28

Potential internal migration by destination of activities

Country	Base	Another scientific institu-tion	Private business research unit	Public administ-ration	Public services	Own private business (non-research	Any work in private sector	No alterna-tives	Retire-ment	Other
Bulgaria	280	33.6	30.4	5.4	1.1	11.8	4.3	9.3	0.7	1.4+2.1
Poland	380	26.8	25.0	5.3	1.9	13.7	7.6	10.5	3.7	4.7
Czech R.	413	27.4	39.7	6.3	2.2	5.1	1.9	8.2	4.8	4.1+0.2
Latvia	301	15.0	11.3	11.0	2.0	6.0	14.0	15.0	9.6	10.6+5.6
Slovenia	288	45.5	21.2	6.6	8.0	4.9	1.4	5.2	2.8	3.1+1.4
Romania	404	40.1	19.1	3.5	4.7	9.9	5.2	10.9	4.0	2.0+ 0.7
Slovakia	516	19.8	36.2	5.0	1.4	12.8	3.4	9.3	6.2	5.5+0.4
Lithuania	192	16.1	12.5	5.7	1.6	12.0	14.6	28.6	4.7	3.1+1.0
Estonia	271	18.5	4.1	14.4	1.1	7.0	20.3	21.0	6.3	-

In its majority so-called firm migrants are thinking to leave for 1-3 years. Natural sciences are planning to leave for Sweden, USA and United Kingdom, in engineer-technical field the priority country for leaving is Germany, social sciences are mainly heading towards USA. All who have made these plans in their majority have only a general idea with whom they are going to work, but 100 percent are all going to continue to work in the scientific field, leavers from universities showing preference towards training, natural sciences are also going to continue in joint research, while social sciences in international organisations. In this category who are planning to go abroad 80 percent are male.

As already mentioned earlier this category who have made arrangements for their departure forms one of the lowest proportions for Estonia among all countries. From the above-mentioned description it can be concluded that the arrangements are done for having concrete fellowships in their speciality for self-development. Among this category only one person has indicated that he is planning to leave forever (engineer-technical field).

Table 26

Ranking of perceptions of Estonian scientists

Perceptions	Emigration		Internal brain drain		Internal brain loss		Stabile personnel	
	Mean rank value	Place	Mean rank value	Place	Mean rank value	Place	Mean rank value	Place
Actual information	4.77	1	3.37	2	3.31	1	3.34	1
Professional fulfilment	4.54	2	3.08	3	3.23	2	3.33	2
Independence of work	4.15	3	3.45	1	3.12	4	3.28	3
Research infrastructure	4.00	4	3.02	4	2.99	5	3.22	4
Job security	3.23	8	2.90	6	3.22	3	3.11	5
Financial prosperity	3.46	7	2.94	5	2.91	6	2.96	6
Key publications	3.92	5	2.84	7	2.84	7	2.95	7
Recognition of colleagues	3.69	6	2.78	8	2.77	8	2.80	8
Status in organisation	3.08	9	2.39	10	2.62	9	2.60	9
Modern way of living	2.84	11	2.41	9	2.25	10	2.28	10
Prestige in the society	2.85	10	2.29	11	2.02	11	2.16	11
Career development	2.69	12	2.14	12	1.81	12	1.85	12

As to the perceptions and value orientations of those arranging departure abroad, they have much higher ranks for the list of values than other categories of people (those not intending to leave, those planning to change the working place in the country). Estonia in general ranks in the first group by the strongness of the values.

The values are clearly forming 3 groups. For all categories (leaving abroad, not intending to leave, intending to change employer in the country) the first group is formed by values which mainly concern the overall working atmosphere (*actual scientific information, professional fulfilment and independence in the work*). In the ranking of these values only those who are intending to change the employer in the

country differ by ranking first independence in the work. Very clear group is formed by external factors like *status in organisation, career development, modern way of living and prestige in the society*. Third group is formed by values which are closely connected with one's own working input.

Those who are oriented for emigration distinguish from other groups not only by the more strong value orientations but also scientific values being of much higher ranking than for other categories. Especially it comes forth in the ranking more highly the value of publication possibilities and recognition from colleagues in contrast to placing financial prosperity and job security much lower. Thus emigration might be here regarded as one possibility to realise one's research interests with greater probability.

4.2. INTERNAL MOBILITY

As mentioned earlier Estonia distinguishes in all categories by low potential of mobility. Internal migration is not an exception. Those who have answered that they are 'definitely, yes' going to change the current employer do not differ very much from other countries with the share of 2 percent. This category of answers show the lowest shares for Czech Republic, Lithuania and Latvia. The difference between countries is brought in by those who rather or definitely do not intend to change the employer during the current year. Estonia again distinguishes among the investigated countries by the highest proportion of those not intending to move (in all 92.5 percent).

Table 27

Potential internal migration by the readiness to leave current employer

Country	Base	Defi-nitely yes	Prob-ably yes	Prob-ably no	Defi-nitely no	Do not know
Bulgaria	964	3.4	5.5	20.0	68.4	2.7
Poland	1170	2.6	6.5	20.4	63.2	7.3
Czech R.	927	1.4	7.9	39.2	49.1	2.4
Latvia	610	1.8	14.9	20.5	50.2	12.6
Slovenia	637	2.2	7.8	32.7	49.0	8.3
Romania	1025	2.0	8.3	24.3	59.8	5.6
Slovakia	918	3.3	14.4	34.8	36.2	11.3
Lithuania	709	1.4	8.2	12.4	67.8	10.2
Hungary	719	3.1	5.4	4.6	84.8	2.1
Estonia	691	2.0	5.4	30.4	62.1	-

Internal mobility is not so clearly research-oriented than it showed up in real migration survey and in connection with the intentions going abroad (see Table 28, p.49). Among those who are going to change the present employer the directions of their future activities vary to a great extent. Among those who have indicated probability of changing the employer still the highest proportion form those who do not see any alternatives to their present working place (21 percent). They are followed by those who are willing to do any work in private sector (20.3 percent). By this proportion Estonia very strongly distinguishes from other countries. However, the proportion of this category is in general higher for Baltic countries, which might indicate just to the later start of transition period in these countries and the welfare in people's minds associating mostly with the prosperity in private sector, where this sector has not yet got into series of bankruptcies. Only then follow state research institutions. Quite a low percent intending to move into private research institution indicates that the opportunity is not to a great extent available and thus has not been established in people's minds as one of the concrete alternatives. The lowest share of the latter in Estonia compared to other countries has to be paid attention to as it is in clear contradiction with the situation which was described by the data on real migration.

Public administration is following by quite a big share, own private business showing also higher share than private research institutions as an alternative to the present working place. After Latvia, Estonia also distinguishes with the great proportion who are going to retire (6.3 percent) which reflects the old age structure of the present scientific personnel.

If to evaluate the intentions of this category by any steps taken to realise their wish, again Estonia distinguishes by the greatest share (88.8 percent Table 29) of those who have only general idea about where to seek for the new working place. Estonia comes fourth after Bulgaria, Latvia and Slovakia also with the low share of those who have contacted new employer (10 percent).

Table 29

Potential internal migration according to the steps taken to leave the current job

Country	Base	Have contacted new employer	Only general idea	No steps taken
Bulgaria	289	4.5	26.6	48.8
Poland	437	11.2	27.9	41.0
Czech R.	416	14.2	25.5	37.7
Latvia	304	5.3	30.9	50.7
Slovenia	307	20.5	29.0	23.8
Romania	412	10.2	30.3	42.7
Slovakia	575	9.6	26.8	42.4
Lithuania	214	15.4	30.4	34.1
Hungary	100	19.0	19.0	35.0
Estonia	260	10.0	50.0	38.8

Another specificity of Estonia is that among those who are weighting whether to leave or stay in science, potential leavers form quite a big proportion. However, Estonia differs from other countries by their age structure significantly: this potential is concentrated in older ages starting from age 45-49 and spreading to pre-retirement and retirement ages. Proportionately more it concerns engineer-technical field, who are in general characterised by older age structure.

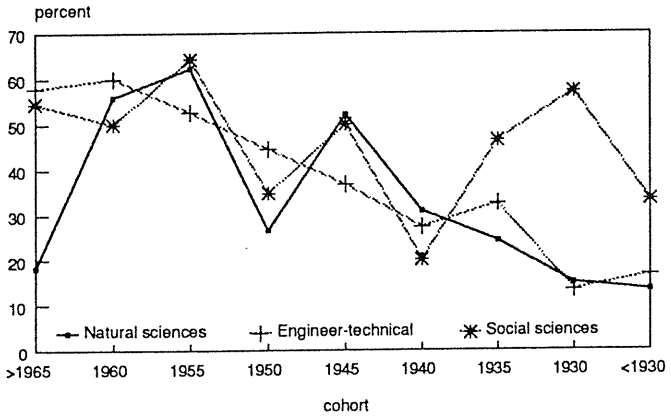
For this category the value orientations are ranking almost similarly to others, except that job security ranks higher than for other categories of personnel, which might indicate that the older research personnel is under the pressure and feels most insecurely in the restructuring process. If leaving, it is hard for them to adjust in a new scientific environment and thus the intention is directed towards leaving the science at all.

4.3. CONCLUSION

In general, the potential migration survey gives grounds to conclude that the Estonian scientific personnel has quite low potential of any kind of mobility, which mainly results from the age structure of it. Research personnel of Estonia, having been reduced during the transition period by 30 percent and owing to the general advancement of ageing process in its population, has in principal in its composition no potential for intensive mobility, due to the restricted funding of science during the whole transition period the latter has additionally reduced the proportion of new generation among the research personnel by the halted process of their entry into science. As mentioned in the overview of the reforming process, in science in general in Estonia, even the significant proportion of post-graduate students are nearly 30 years old, which indicates to a very late start of independent research life as a whole for the country. All these processes combined together have formed the research

personnel of the current day, whose main characteristics is being one of the oldest research communities among the East European countries and with a significant proportion of those who have worked in the scientific field most of their working career. Thus it is the basis for general low potential for any kind of mobility, whether in direction towards foreign countries or inside the country.

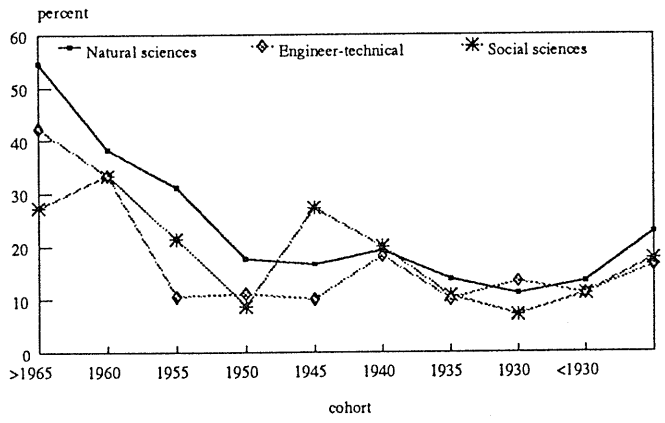
FIGURE 25. POTENTIAL FOR TOTAL MOBILITY
POTENTIAL MIGRATION SURVEY, ESTONIA 1995



However, surveys on the potential offer the possibility to envisage the volume, direction and pattern of the threat to the community under investigation, on condition that all circumstances would favour the realisation of such potential. Although improbable from the viewpoint of real behaviour, as the warning, the scope of total potential mobility can be brought out by three main scientific fields (Figure 25).

Social sciences are in this case showing the highest probability of potential mobility with 44.4 percent, if evaluated by the readiness of changing their current employer. However, although the potential abroad rate is comparatively high as well (17.1 percent), the major part of the potential is going to realise rather inside the country. Another difference from other fields of science is that the potential for mobility has not significantly concentrated into some particular ages, but is spread among all, the general mobility maybe more affecting the most active cohort born in 1955-1959 (total potential of the cohort is around 65 percent!), to the potential for emigration mostly the cohort of 1945-1949 is contributing and the potential is remaining relatively high for all older cohorts, exceptionally from other fields of science.

FIGURE 26. POTENTIAL EMIGRATION BY SCIENTIFIC FIELDS
POTENTIAL MIGRATION SURVEY, ESTONIA 1995



Natural sciences are following with the general mobility potential of 36.1 percent among all engaged in this field of science. Among them major proportion of the mobility is intended to realise towards foreign countries (22.2 percent), especially falling to all the younger cohorts. Thus the mobility of natural sciences is more the problem of the young, the emigration intention concerning in the youngest cohort more than half of them (54.5 percent, see Figure 26).

Engineer-technical sciences are closely following the pattern of the other scientific fields with 35.1 percent of potential mobility. However, as this field of science is already characterised by a significant discontinuity in their age structure, the potential is realising among the very youngest (the only field, which has relatively high proportion of the youngest research personnel) and the oldest personnel (has also the highest proportion of the oldest personnel).

It is hard to believe that such kind of potential should realise, in case it would, in some cases it involves more 60 percent of the cohort engaged currently in science. However, the serious outcome of the survey is the discontinuity which might be the co-result of the transition period. Although, in general the transition period for Estonia might be regarded as quick and efficient, reduction of the research personnel has involved more than one third of the personnel in 6 years, last year showing the trend of stabilisation. The outcome of such a reduction to the whole scientific community is that given generally the older age structure, the research community has become one of the oldest among the East European countries.

Estonian scientists are older and with prolonged working experience in the field. It means that science has gained the core personnel which in general has very clearly determined its perspective in this field of activity. Thus, on the background of relatively later beginning of the transition period, quite high integration of Estonia' s research personnel into international scientific community does not come as a surprise. Indication for the latter statement can be found in a higher proportion of those involved in joint international projects, high proportion of international contacts whether having been abroad by fellowships or by short-term contracts in its own speciality. Even the amount of publications abroad is higher the average per a scientist in Estonia, which if to take into account that the opportunities for that have become available only during the transition period, already speaks for itself. Scientific environment of Scandinavian countries together with its nearness, insignificant language barriers and similar environment as a whole have contributed to the lessening of the potential of real emigration.

Although in general both surveys have revealed that the main orientation of the mobility, whether the realised one or potential, is highly oriented towards science, which mainly indicates the intensiveness of the reforms and restructuring in this field of activity, the relatively high emigration rate in real migration survey not correlating with the very low potential of this mobility direction in the potential migration survey needs to be paid attention to.

First, Estonia differs among other East European countries by the age composition of the real emigration, which does not correspond to the initial potential of it among the research personnel (see Figure 13) and although high has not resulted in the relevant gap by 1995. It seems that the significantly different age structure of those who have emigrated Estonia during the transition period from all other countries under investigation, especially regarding the main peak in the ages 30-34, needs a more thorough study. Potential migration survey provides some insight into the category of those who can be regarded as firm emigrants, but due to the very low potential, which means very few cases, it does not offer a full answer. However, the general explanation might be, that no matter the high proportion of those who have emigrated, they add to the significant flow of temporary exits into the international scientific environment, thus in the end contributing to the new structures emerging in Estonia's science. The latter statement is based on the very high proportions of short-term (up to 6 months) oriented emigrations whether it concerns fellowships abroad, in connection with joint research work or part-time job. The inclusion in the real migration survey a sample of those who presently have a valid working contract with their home institute but are currently abroad form almost two third of the emigration flow for that year showing the high rate of turnover of the international contacts. The closeness of Scandinavian countries and the highest intensity of contacts falling to these countries suggest that the emigration might be evaluated as a part of brain exchange process between these countries. As the real migration survey did not take into account the entry and re-entry process into the scientific institutions during the investigated period, it is hard to evaluate how many of the so-called emigrants have in reality returned. The age structure of the research personnel by 1995 suggests that the reduction of the personnel has mainly resulted by the process of the young not entering in this field of activity.

The trends in real migration indicate that science has lost quite a proportion of the older personnel, whether by retirement (not revealed in the survey data) or emigration and internal migration. However, due to the advanced ageing process the reserach personnel by 1995 has still become older. The internal migration reveals that those who have gone for other than science fields of activities have been rather lesser qualified and rather older than the young non-experienced personnel. On the background of lower proportion of females engaged in science in general, the real migration trends have not generated any disproprtions by sex.

The turnover of personnel inside the science is according to the survey data quite insignificant. The data from real migration survey indicates towards the high competitiveness of new scientific structures. The structure of the personnel who is emigrating or moving into new science strucutres is by all charateristics very close. However, the potential migration survey indicates, that never mind the highly research-oriented personnel who has remained in science, in its orientations (although potentially) they are much more regarding the possibilities of leaving into non-research areas and private initiatives than the data from real migration has brought out.

The Estonian data mainly refers to basic state research institutes: main universities and academic institutions which involve more than 85 percent of the research personnel. Both datasets reveal that the restructuring process has in the first place concerned academic institutions in all aspects: real migration intensities have been higher, reduction of personnel towards more research-oriented more visible, international contacts more intensive. The process is understandable because academic institutes were during the Soviet period more fundamental research based institutions. The reform of the R&D system in Estonia also first focused on the academic institutions. As the result the academic institutes have clearly benefitted from that, their age structure being relatively younger and in formal sense more qualified. However, the potential migration survey indicates that the process has also enlargened towards universities. Nevertheless, if to evaluate their integration into the intenational research community, their orientation mainly towards training, not so much basic research still reveals the basic difference in orientations of these two types of institutions.

As the conclusion, the project revealed that Estonia has quite a different position from other East European countries in many aspects. Belonging to the group of countries whose transition towards open society has started relatively later, Estonia still belongs to the forerunners in the science reforming process and the rate of integration into international research community has been very high compared to the short period of its openness. The effects of the transition period in general terms are indicating towards the high speed and effectiveness of restrucutring processes in the country. Estonian research personnel has become more homogeneous, determinantly research oriented and in general the loss effects have contributed to the better qualifed and experienced personnel's formation in scientific community. In that sense the economic restraints of the period, which have been comparatively the highest among the investigated countries, have to a certain extent had rather a positive effect. Nevertheless, one of the main negative effects of the period has clearly been the halt of the entry of new young personnel into science. If that trend is going to continue the positive sides might turn into a real problem, which might be the basis for such a discontinuity in this field of activity that science is not going to recover from. The balanced reproduction of human capital is the crucial point in the general development of a little country which is demographically advanced. The low potential of mobility is the result of such demographic development of the population and indicates that reduction due to transitional effects cannot be realised any more. Ageing of the Estonian research community undoubtedly leads to its further reduction but by the demographic processes. Estonia stands before the task to juvenalise science, if the country wants to maintain the international competitiveness of its human capital.

V REFERENCES

Coale, Ansley, Barbara Anderson and Erna Härm (1979). *Human fertility in Russia since nineteenth century*. Princeton.

Coleman, David.(1995). Demographic Change in countries of Central and Eastern Europe: current situation and trends. Paper presented to *Colloquy of Council of Europe on the demographic profile of the countries of Central and Eastern Europe: advantage or obstacle to development*. November 19-21. Riga.

EBRD (1994). *Transition Report*, October. London.

Katus, Kalev (1990). Demographic development in Estonia through centuries. *Yearbook of Population Research in Finland, vol.28*. Helsinki, pp.50-66.

Katus, Kalev (1991). *Fertility trend and regional differences in Estonia*. RU, Series B, No.12. EKDK, Tallinn.

Martinson, Helle (1995). *The Reform of R&D System in Estonia*. Estonian Science Foundation, Tallinn.

OECD (1993). *Short-term Economic Statistics. Commonwealth of Independent States*. 1980-1993. Paris.

Rajasalu, Teet (1995). Macroeconomic stabilization and development.*Transforming the Estonian Economy. Ed. by Olev Lugus and George Hachey Jr*. Tallinn, pp.16-51.

Rhode, Barbara (1991). *East-West migration/Brain drain. Mapping the available knowledge and recommendations for a European Research Programme. Cost Social Sciences*. Brussels.

Sakkeus, Luule (1994). Baltic States. *The Politics of East-West Migration. Ed. by Solon Ardittis*. London and New York, pp.68-85.

Sakkeus, Luule (1995). Post-war migration trends and the formation of the foreign-born population in the Baltic states. *Intercultural Communication and Contact. Ed. by Øyvind Dahl*. Stavanger, pp.176-205.

Taaler, Jaan (1995). Economic reforms: the main stages, programmes and evaluations. *Transforming the Estonian Economy. Ed. by Olev Lugus and George Hachey Jr.* Tallinn, pp.1-15.

UN ECE (1995).*Economic Survey of Europe in 1994-1995*. New York and Geneva.

Vishnevsky, Anatoli and Andrei Volkov (1983). *Reproduction of Population in USSR* (in Russian). Moscow.

Zvidrinsh, Peteris (1978). The dynamics of fertility in Latvia. *Population Studies 33, 2*.