EVALUATION OF NATIONAL OUTPUT AND SCIENTIFIC PRODUCTIVITY IN THE BIOMEDICAL FIELD OF SEVERAL EASTERN EUROPEAN COUNTRIES IN THE 1989-1995 TIME PERIOD USING MEDLINE

A Master's Research Paper submitted to the

Kent State University School of Library and Information Science

in partial fulfillment of the requirements

for the degree Master of Library Science

by

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August, 1997

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ABSTRACT

MEDLINE was used to measure indicators of scientific productivity and national output in the biomedical field in several Eastern European countries (Bulgaria, Czechoslovakia, the Czech Republic, Hungary, Poland, Slovakia, and Romania), for the 1989-1995 time period. Significant decrease in the scientific production and national output of Bulgaria, Czechoslovakia, and Romania were observed in 1991 and 1992. A similar (but less pronounced) tendency was demonstrated in Hungary and Poland. At the same time, for three other European countries (Finland, the Netherlands, and Sweden), which have not experienced such dramatic changes, the same indicators were found to increase (for Finland) or remain almost the same (for The Netherlands and Sweden), during the 1989-1995 time period. These differences between the Eastern European countries and the control countries could be attributed to the significant political, economic, and social changes that have been in progress since 1989.

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ACKNOWLEDGMENTS

I would like to most sincerely thank my adviser, Dr. Mary Kim, for helping me better see the problems approached in this paper, as well as for making useful comments on the manuscript.

I will always remember Dr. Tschera Harkness Connell's classes as a trully intellectual challenge and pleasure.

Gratitude is also expressed to Dr. Lois Buttlar, whose course on research methods was very helpful in writing this paper.

CHAPTER I. INTRODUCTION

Since the end of World War II until the late 80s, the geopolitical region, presently occupied by Bulgaria, the Czech Republic, Hungary, Poland, and Slovakia, was part of the bloc of Eastern European (COMECOM) countries governed by socialist governments. The political changes that swept Eastern Europe at the end of 1989 had dramatic consequences on the development of the whole region (Bradburne, 1993; Bruszt & Stark, 1992; Judt, 1992; Mastny, 1992). They have been followed by economic changes, probably more accurately described as chaos or collapse (Michta, 1992; Turczak, 1994).

The recently introduced market economy in the region is dramatically transforming the organization and funding of science (Dickman, 1992; Rabkin & Mirskaya, 1993). The latter traditionally had three sources: government, military, and industry. Government budgets now are tight and unpredictable; the military complex has also been forced to downsize and is less willing to invest in research and development. A similar situation exists in industry. The lack of hard currency for buying chemicals and equipment for research institutes, as well as for paying for subscriptions to western scientific journals, is affecting the level of scientific research and is forcing many institutes and universities to downsize and prioritize the areas of research (Turczak, 1994).

The support for scientific research constituted an important aspect of the propaganda and ideology of the previous socialist governments. In the 1980s, many scientists from Eastern Europe were given the opportunity to specialize in well equipped laboratories in the West. Together with the new scientific expertise and ideas that they brought back to their countries, these scientists also established close collaborations with colleagues abroad. During this period of time, the number of publications by Eastern European scientists in international journals significantly increased (Braun and Glanzel, 1996). Scientific exchange during this period of time was on the rise and many international scientific meetings were organized and held in the former socialist countries. All these

factors contributed to the opening of Eastern Europe to the international scientific community and undermined the existing communist regimes. Thus, it is not surprising that the scientists represented a major force in bringing the political changes to these countries in the late 1980s.

A troubling tendency that has been noticed in the 1990s is a decline in international scientific collaborations of the Eastern European countries with the countries in the West (Braun and Schubert, 1996). The fact that many capable Eastern European scientists are heading en masse to the West (Braun and Glanzel, 1996) or to the increasingly attractive private business sector, may also contribute to a decline in the scientific research in these countries.

The transition period which the Eastern European countries have been experiencing since 1989 is characterized by a shift in priorities in the cultural, moral and educational values. More research is needed to be able to predict how the different areas of scientific research would be affected by these changes and which disciplines will be favored over others.

Biomedical research is regarded as vital for the recovery of these nations from many years of neglect of the environmental pollution and its consequences on human health. In the last few years new facts about aggravated environmental conditions in these countries and their effects on human health have been revealed (Feachem, 1994; Jamrozik, 1995; Neff-Smith & Moore, 1995; Zatonski & Tyczynski, 1993). Life expectancy in Eastern Europe has stagnated since the mid-60s, whereas in Western Europe it has increased. In the past three decades, rates of chronic disease mortality and premature mortality have increased in all Eastern European countries, giving rise to an East-West health divide.

Under socialism, public discourse on topics related to the impact of environmental conditions on human health was controlled by the local governments and people abroad were usually better informed about the real situation in polluted areas than those who were living there. The peoples of Eastern Europe, for example, learned about the Chernobyl disaster from western sources. Initially, many local governments even refused to acknowledge that such an accident had occurred at all. In some Eastern European countries, scientific research on the pollution of the

environment and the consequences of radiation on human health was even banned. Statistical data (whenever they existed) were strictly classified and were not available even to the scientific community.

In view of the existing environmental and health conditions in Eastern Europe, the level at which biomedical research is conducted is of major importance. Prevention of environmentally related cancer can be significantly enhanced by the availability of sensitive early warning systems and quantitative assessment of human risks. The development of new approaches, such as the use of biological markers to identify risks well before clinical onset of the disease, would allow early intervention and treatment. Recent advances made in the fields of molecular biology, biochemistry, and toxicology can greatly contribute to the early diagnosis of biological changes which may evoke cancer. For decades, though, research in the field of molecular biology in Eastern Europe has lagged behind that in the West. At the time when Watson and Crick discovered the structure of DNA, the word "gene" was banned from the vocabulary of Soviet scientists. The dark age of the sadly known "Lysenko period" in Soviet science has also affected (and hindered) genetic research in all the other socialist countries (Soyfer, 1994).

Eastern Europe is not an island and what is happening there cannot be ignored by the other European countries. The extreme environmental air pollution, such as that found in the highly industrialized Silesian region of Poland, is drifting also into Germany and the Netherlands and has been associated with increased risk of cancer and adverse reproductive outcomes (et al., 1992). It is evident that the problems of health care and biomedical research need to be addressed not only by the local governments, but also by the whole international community.

This paper examines the extent to which the Eastern European scientific community is addressing these problems in the research literature. A bibliometric analysis is used to assess the biomedical research productivity of Bulgaria, former Czechoslovakia, the Czech Republic, Hungary, Poland, Slovakia, and Romania for the period 1989-1995.

CHAPTER II. LITERATURE REVIEW

Biomedical research in the Eastern European countries is being performed mainly in the institutes of each country's Academy of Sciences -- a huge centralized organization which incorporates many individual research institutes. The changed economic conditions in these countries have increased competition among academic institutes for the limited funds and resources. Since the possibility to get funding is becoming more and more dependent on the performance of individual scientists, groups, and whole institutes, criteria for evaluation of scientific research are attracting significant attention in these countries.

Elaboration of criteria and reliable indicators for the quantitative and qualitative analysis of scientific production of individual scientists, organizations, and countries is one of the major problems that needs to be addressed in bibliometrics and scientometrics (Martin, 1996; Vinkler, 1996). Publications, as typical products of research work, are recognized indicators used for evaluation of scientific activity (Buchholz, 1995; Kostoff, 1996). The number of papers produced by a given research institution, or by a country as a whole, is certainly a basic measure of its output. The *scientific paper* , as defined by Vinckler (1996), is the scientometric unit of information in natural sciences. A "paper" includes such types of publication as"standard" papers, reviews, short communications, notes, and letters. In most bibliometric studies in the biological sciences, a count (of a paper) can be an article, note, letter, or review in a refereed research journal (Narin and Hamilton, 1996).

Most of the bibliometric analyses use several basic indicators that are widely and almost universally accepted (Narin and Hamilton, 1996). The counts of the number of papers provide a basic indicator of the amount of scientific productivity. The counts of citations to these papers provide indicators for the quality of research. Co-authorships, and especially multiple extra-institutional and international co-authorships, are an indicator of quality, the assumption being that scientists who cooperate with their colleagues in other institutions and overseas are considered to

be doing quality research than those that a relatively isolated. Kostoff (1996) pointed out that while the number of all articles published by an individual, organization, or country is an indicator for total scientific output, the number of the papers published in peer-reviewed journals provides quality dimension to raw counts of papers. In addition to the indicators mentioned above, this author listed several other indicators as essential in evaluating scientific performance. These include publications in peer reviewed books, conference proceedings, competitive grants, and others.

Evaluation of the significance of scientific research and scientific publications using the number of citations of publications was introduced by Eugene Garfield, founder of the Institute for Scientific Information (Philadelphia) and primary theorist of citation analysis. Although there exists a general agreement in the literature about the importance of publications in refereed journals as performance indicator, some authors expressed doubts about the use of *SCI* to evaluate scientific performance of researchers, journals, institutions, countries, and even disciplines. Moed and Leewen (1996) analyzed the way in which the impact factor of journals is being calculated by ISI and came to the conclusion that the concept of citeable documents is not defined accurately. Klimley (1993) expressed her concerns about the validity of this approach in analyzing research in narrower disciplines such as geology. She criticized the uncritical use of the *SCI* for promotion of scientists, journals, projects, and pointed out the consequences that this might have on the trends in science and the life of individual scientists.

Cameron (1995, p.1) wrote that "the available indexes (principally, the *Science Citation Index* and the *Social Sciences and Humanities Citation Index*) tend to be very narrow in their coverage, indexing journals only and selected ones at that. The journal selection tends to change slowly over time, often failing to keep pace with the development of new journals... Furthermore, the existing indexes also suffer the datedness of all post-publication indexing: papers may first appear in the index several years after they have been written." Some of the problems with citation analysis, for example, can be very serious: intellectual link between citing source and reference article may not always exist; incorrect work may be highly cited; methodological papers

are among the most cited; citations could be lost in automated searches due to spelling differences, inconsistencies, and even typographical errors. The growing use in the West of citation counts to assess the quality of researcher's work, with ramifications for status and promotion, is leading to excessive self-citation, or citation of groups and people citing each other without real justification (Dickenson, 1996).

Garfield used two indicators of journal significance: total citations and impact (Garfield, 1972, 1976, 1979). The first is simply the number of times a journal was cited. Impact, on the other hand, is a measure of the relationship between citations and articles published. Garfield defines the impact factor of scientific journals as "a measure of the frequency with which the 'average cited article' in a journal has been cited in a particular year (Garfield, 1976). Journals that have high impact factor are listed in the *Journal Citation Reports (JCR).* The *SCI* database is very selective and covers only a limited number of journals (Cameron, 1995) -- mainly those which have high impact factor. As the following discussion illustrates, language of publication and journal accessibility are two factors which may adversely affect a journal's impact factor.

When analysis of national output is to be performed, it is important to use a database that covers not only English language journals, but also those published in other languages. It is impossible to perform a realistic evaluation of the total national output of an individual country without taking into consideration articles published in its national journals, or those that were published in foreign journals that are not listed in *JCR.* As pointed out by Magri and Solari (1996), *SCI* provides very limited coverage for non-English language journals. In contrast to the *SCI* database, MEDLINE is more inclusive of journals published in other than the English language and of journals that do not necessarily have a high impact value. This allows for a better quantitative estimation of the total scientific output of a country. Publishing in international journals is sometimes unjustified for topics that are important mainly for a particular country. This does not mean that some of this research is not important and does not deserve the attention of the international community. Status and balance in representation of laboratories, nations, and others,

play a role in the decision making of high impact journals with regard to their policy of accepting papers for publication (Buccholz, 1995). Until the beginning of the 80s, the East European countries were quite isolated from the rest of the world, and for the scientists in this region, publishing their works in international journals, in general, and in high impact journals, in particular, has been and is still a problem.

Most of the studies comparing the national performances of the East European countries used the *SCI* database (Braun and Schubert, 1996; Braun et al., 1995) which is heavily biased in favor of the English language journals and is not a comprehensive indexing service. Braun et al. (1994a,b; 1995; 1996) studied the "scientometric weight" of different countries, using the *SCI*, as a data source. Scientometric weight was calculated by taking into consideration the absolute national publication output, and its share in the world total; and, the absolute number of citations received by the countries' publications and their share in the world total. In their study, they considered only countries that had produced at least 1000 papers in five major science fields (i.e., life sciences, engineering, mathematics, physics, and chemistry), in a given period of time. Papers were assigned to countries according to the corporate address of the first author, as indicated in the byline of the publication. Only original papers, review articles, notes, and letters, covered by the SCI source journals in the period 1980-1993 were included in these studies. The authors also studied the citations to these publications for the same period of time. They determined the absolute number of citations received by the countries' publications, and their share in the world total. These papers report on the publication output and citation impact of many countries, including several countries from Eastern Europe, for the 1980-1993 time period. Since these studies were entirely based on the *SCI* database, which does not cover the national scientific journals published in these countries, they are not complete and representative of the total national output of these countries.

Grupp and Hinze (1994) studied the efficiency and international connections of former East and West Germany, and compared the results with those obtained for United Germany. They rated

as efficient only those areas of science that showed maximum scientific collaboration on international level. The authors evaluated the degree of specialization of both former German states in certain areas of science, and introduced a relative indicator, international orientation, to measure "internationality" of the research performed in these countries. This indicator is based on the average citation rate for journals in which West and East German scientists actually publish. It is set into proportion to the world-wide citation rate, for all journals included in the SCI database. It was admitted, though, that "this measurement concept of internationality is by and large biased to the Western, English-speaking science through the selection of an American-based database" (Grupp and Hinze, 1994, p. 91). These authors also discussed the reasons for publishing in high or low cited journals. One of the points that they made referred to "non-science determinants, such as political dictates which could influence the publication strategy."

Miquel et al. (1995) used an ISI multidisciplinary database (over 6 million bibliometric entries from 1981 to 1992) that is founded on top-echelon journals, to define a publication pattern of 48 nations in 18 scientific disciplines. The authors calculated the publication output (expressed as percentage share of total world output) and showed the priorities given to some disciplines, in these countries.

Some studies deal specifically with evaluation of the sciences in the countries located in Eastern Europe. The first studies of East European science were performed by Garfield (1976a). He evaluated the impact factor of 73 scientific journals published in Bulgaria, former Czechoslovakia, Hungary, Poland, Romania, and former Yugoslavia. He also presented a list of highly cited articles from eight of these journals and analyzed the topics and languages in which the papers were published (Garfield, 1976b). The author admitted that coverage of East European journals in the *SCI* database that he had used was limited and there might have been more highly cited articles that were missed perhaps because some of them were published in languages other than English or German.

Braun and Schubert (1996) used *Scientometric Indicator Datafiles*, in which the data are

derived from the *SCI* database, to study indicators of research output in the sciences from five Central European countries (i.e., Austria, the Czech Republic, Hungary, Slovenia, and Slovakia), for the 1990-1994 time period. Country assignment was based on all authors, e.g., a full publication was counted for each country, if any of the authors had an institutional affiliation from that country. The authors also made city assignments on exactly the same basis. Time trends were taken on "volume year" basis, with publications being assigned to the year they appeared in the *SCI* database, rather than actual publication date. "Articles," "Letters," "Notes" and "Reviews were considered, as type of publication. Five major areas of science were considered: life sciences, chemistry, physics, mathematics, and engineering.

The indicators for each of the five countries were presented in uniform way, in terms of distribution of publications by: 1) type; 2) city; 3) language; 4) publication counts and distribution by major fields; 5) most frequently used journals by major fields; 6) publication counts in "European" and "American" journals; and 7) trends and patterns in international cooperation. The "type," "city," and "language" data are presented together, for the whole period included in the study, and for each country separately. The publication counts were presented as annual output and divided by the five major fields. The articles were found to account for 91-98% of all publication types; more than 85% of all publications were published in the English language. The publications in the national languages of the countries constituted 15, 4, and 3% for Austria, the Czech Republic, and Hungary, respectively. Interestingly enough, for Slovakia, 5% of the publications were in the Czech language and there were no publications reported in the national, Slovak, language, of this country. This result supports the previously mentioned limitation of coverage of the SCI database with respect to national journals from Eastern European countries. The general conclusion drawn from this study was that "there were no signs of any dramatic change either in overall or in the disciplinary trend" (Braun and Schubert, 1996, p. 163). From 1990 to 1994 the annual publication counts increased for Austria, Hungary, and Slovakia, while for the Czech Republic a decrease was observed in 1991, followed by recovery to the same level as

in 1990. In the case of Slovenia, there was a slight decrease in 1991, followed by significant increase between 1992-1994. It is difficult to interpret the results for Slovakia and Slovenia, because the study covers the time period between 1990 and 1994, while these countries became independent only in 1993.

In this paper, the authors referred to previous studies which showed that throughout the 80s, an enormous rise in the proportion of internationally co-authored papers could be observed in Bulgaria, Czechoslovakia, Poland, and Romania. They attributed this phenomenon to the gradual opening of these societies, but also to a necessity of compensation, to counterbalance the detrimental effects of the countries' economic problems. The authors concluded that in the four ex-socialist countries, great efforts had been made not just to maintain the level of research activities of the previous years, but also to conform to western standards.

Parodi et al. (1993) assessed the scientific productivity in the cancer field of several countries from the European Community, as well as of some other countries (e.g., the United States, Canada, and Japan), by counting the number of papers published during the 1988-1990 time period in 15 of the top scientific journals which had the highest impact factor in the field "Oncology," according to *JCR* . They normalized the total number of published works by dividing by the number of inhabitants of a given country. The sample of the population studied included articles, original reports, special reports, review articles, perspectives in cancer research, advances in brief, all these being types of publications in the selected oncology journals.

At least two publications discussed scientific collaboration between East European countries and the West (Braun & Glanzel, 1996; Plaza et al., 1996). Braun & Glanzel (1996) studied the total publication output (publication count) and the share of international papers for Bulgaria, Hungary, the former Czechoslovakia, Poland, and Romania for the periods 1981-1985 and 1984-1993, respectively. Their data were also based on the Institute for Scientific Information's *SCI* database and did not make distinctions between the publications in different fields. The authors concluded that Eastern European science used international collaboration as a

partial compensation for the negative financial effects which have hit basic research in these countries before and after the political and economical changes in the nineties.

Some authors used MEDLINE to study different aspects of biomedical research. This database covers a significant part of the world literature in the biomedical field, including many national journals, which allows for a better and more realistic evaluation of the publication patterns and total output of articles published by scientists from these countries in this field than the *SCI* database. MEDLINE has been used on several occasions to perform bibliometric studies.

Haiqi (1994) used MEDLINE and its MeSH keywords for a bibliometric study of the area of traditional Chinese medicine. He searched by one subject heading of MeSH (keyword for MEDLINE): Medicine-Chinese-Traditional, with all its subheadings. He further limited his searches with respect to year of publication, language, country of publication, and source (i.e., journal title).

Takahashi et al. (1996) studied articles related to epidemiology and published in occupational health journals. They showed the trends in this field and how these changed over the years in the 1980-1993 time period. By conducting an on-line DIALOG search on MEDLINE, the authors created a list of selected occupational health journals in which the most commonly indexed topic was "occupational diseases." A journal was included in this list if: (a) it ranked among the top journals in the number of papers published on occupational diseases; (b) it was categorized under "public health" in *JCR*; and (c) it began publications in 1980 or before. The application of these criteria allowed for the selection of eight occupational health journals which were considered reasonably representative of occupational health literature. Articles published in these journals (source items) were limited to those written in English. Reviews, editorials, and letters, as document types, were excluded from the study. By using descriptors representing major concepts (called "major descriptors"), it was possible to limit the number of retrieved records to only those of them in which the main emphasis of the document was on the selected term or phrase. The results showed the number of source items, and number and proportion of source items indexed by

epidemiology both as a descriptor and a major descriptor published by representative occupational health journals for the study period. This study, in fact, combined the possibilities to perform various searches on MEDLINE, but it also relied on the rankings provided by *JCR*, to select a group of journals on which to perform the investigation.

The developments in Eastern Europe in the last few years offer an interesting model for evaluating national scientific activities when an external factor (the political and economic changes) is involved. The results from this investigation will be important not only as a pure evaluation of the developments in the life sciences in these countries, but can also elucidate some socio-economic and demographic problems. No other group of countries in world's recent history has experienced changes of this magnitude and character.

CHAPTER III. OBJECTIVES

The objectives of this study include evaluation and comparison of the publishing patterns in reporting biomedical research in several East European countries for the 1989-1995 time period. There are natural differences in citation and publication patterns across research, unrelated to quality of the science, and adjustment for these differences should be made. Different approaches for "normalization," i.e., comparing results to an accepted standard, can be used. One way of normalizing the results for a given country, or group of countries, is to compare them to an appropriate standard, e.g., other countries or group of countries. In order to evaluate the growth in research in a particular scientific field for a particular country, the results obtained for this country were compared with those observed for other European countries, in the biomedical field. Another type of normalization used in this study is to divide the number of publications of a particular country by the number of its inhabitants.

With the increasing tendency among all scientists toward publishing their articles mainly in English language journals (Guardiola & Banos, 1993), it will be suitable to compare the East European countries to other non-English speaking countries, such as Finland, the Netherlands, and Sweden, which have not experienced such dramatic political and economic changes as the Eastern European countries, and in which English is not a national language. An effort was also made to relate the scientific productivity and performances of the Eastern European countries to the timing of political and economic changes in this region.

The main goal of the work presented here was to evaluate the biomedical research performed in Eastern Europe in the transition period which started in 1989 and is still going on. In order to achieve this goal, the MEDLINE database was used to examine the scientific production in the biomedical field in several Eastern European countries. The time interval for the study (i.e., 1989-1995) was selected so as to include the period from 1989 (when the political changes took

place), until 1995 (to allow for the incorporation of all records in the MEDLINE database[1]).

This study was designed to answer the following specific questions:

1) What is the total output of each country in terms of the number of articles published (abroad or inside the country) by scientists affiliated with institutions in this country;

2) What is the output of a country in terms of total number of articles published inside this country;

3) For the articles published by the scientists of a particular country, what is the number of those published in the national language(s) *vs* those published abroad.

1 There usually exists a lag between the publication date of an article in a journal and the date when its record appears on MEDLINE.

CHAPTER IV. METHODOLOGY

The main data source of this study, the MEDLINE database, is based on *Index Medicus* and covers the international literature on biomedicine. It provides references to articles from 3900 journals published in the US and 70 other countries. The scope of the database is limited to the biomedical research, allied health fields, biological and physical sciences, clinical practice, administration, policy issues, health sciences librarianship, health care services, humanities, and information science related to medicine and health care. MEDLINE covers articles, notes, letters, and review articles published in scientific journals since 1964 to the present. Online searching can be done on the following (but is not limited to) the following information fields: author's name, journal name, language of publication, type of publication, institution and country of publication. Two factors determined the selection of the time period for this study. The first is the fact that the institution (the address of the institution with which the first author is affiliated) field and the "country of publication" fields have become available on MEDLINE in 1988 and 1989, respectively. The second factor is related to the beginning of the transition period in Eastern Europe which started at the end of 1989.

Sample: The population sample included the following Eastern European countries: Bulgaria, Czechoslovakia, the Czech Republic, Hungary, Poland, Romania, and Slovakia. The number of articles obtained for Czechoslovakia, the Czech Republic and Slovakia will be grouped together and the results will be presented under a collective name, Czechoslovakia. The results obtained for these countries were compared to those found for Finland, the Netherlands, and Sweden. The term "article" will be used throughout this report to designate all types of documents found in the MEDLINE database. These include "regular articles," "notes," "letters," and "review articles." This study covers the period between 1989 and 1995.

Data gathering: The OVID software version of the MEDLINE database was used in this study. The results presented in the figures are normalized by dividing the number of articles by the population of the country (in millions).

The following indicators were used in this study:

1. The number of articles published in a particular country (**Country**) can be retrieved by searching on the name of the country in the field "Country of publication." This includes both the articles published in the national language of this country and those published in the country, but in a foreign language. For example, by performing the following search:

> hungary.cp.

all articles published in Hungary can be retrieved. The number of articles published in either Czechoslovakia, the Czech Republic, or Slovakia was found by combining the names of these three countries and searching on the same field:

> (czechoslovakia OR czech republic OR slovakia).cp.

2. The number of articles published in the national language(s) of a country (**National lg**) was obtained by using a three-letter code for the language, as in:

> hun.lg.

MEDLINE has established the following language codes which allow searching on the language of the publication: bul (Bulgarian), cze (Czech), dut (Dutch), fin (Finish), hun (Hungarian), pol (Polish), rum (Roumanian), slo (Slovak), and swe (Swedish). The number of articles published in the national languages of Czechoslovakia, the Czech Republic, and Slovakia was determined by using codes, corresponding to Czech and Slovak languages:

> (cze OR slo).lg.

3. The number of articles in which the first author was affiliated with an institution in a particular country was determined by searching the "institution", or address, field. For example:

> hungary.in.

retrieved all articles in which the name"Hungary" is spelled out in the institutional address of the first author. The number of articles in which the name of either Czechoslovakia, the Czech Republic or Slovakia is spelled out in the address of the first author was obtained by performing the following search:

> (czechoslovakia OR czech republic OR slovakia).in.

4. The total number of articles published by scientists from a particular country was determined by combining the searches outlined in 1,2, and 3. The following assumptions were made when designing a search to retrieve all articles published by an author:

1. Journals published in the national language(s) of a country do not list the name of the same country in the institutional addresses of the authors; thus, a search performed on the name of the country (in the MEDLINE "Institution" field) will not retrieve those articles that were published in national journals. It will retrieve only those articles that were published in other than national journals.

2. In order to exclude the possibility that articles published in the national language(s) of a country were published in a country other than the country under consideration, the search on the language(s) of this country is combined with the search on the name of the country, in the field "Country of publication."

3. The total number of articles published by scientists from a particular country requires that the results obtained by searching on the name of the country in the "Institution" field were combined with those obtained by combining the searches on the language(s) of the same country and the search on the country' name in the field "Country of publication." For example, by performing the following search:

> hungary.in. OR (hungary.cp. AND hun.lg.)

it will be possible to retrieve all articles that were published by Hungarian scientists and that are available on MEDLINE. By using the Boolean operator AND in this search, it is possible to retrieve only those articles that were published in Hungary and in the Hungarian language, thus excluding from this number those that might have been published in Hungary, but by foreign scientists. In a similar approach, the total number of articles published by scientists from Czechoslovakia, the Czech Republic, and Slovakia will be determined by performing the following searches:

1. > (czechoslovakia OR czech republic OR slovakia).in.
2. > (czechoslovakia OR czech republic OR slovakia).cp.
3. > (cze OR slo).lg.
4. > 1 OR (2 AND 3)

5. The number of articles published abroad, by scientists from a particular country, was determined by subtracting the number of articles that were published in the same country, from the total number of articles published by scientists affiliated with institutions in this country.

6. The number of articles published in a country, but in other than the national language(s) of the country was determined by subtracting the number of articles, published in the country, in the national language(s) of the country, from the total number of articles published in this country.

Terms and abbreviations used in tables and figures:

Total -- the total number of articles published by the scientists of a particular country. This includes the articles published abroad and those published inside this country. For example, the total number of articles published in 1990, by Hungarian scientists, was obtained by performing

the following searches:

1. > hungary.in. OR (hungary.cp. AND hun.lg.)
2. > ..l/1 yr=90

Country -- number of articles published in a particular country (MEDLINE filed: "Country of publication"). For example, the number of articles published in Hungary, in 1990 will be obtained by performing the following searches:

1. > hungary.cp.
2. ..l/1 yr=90

Abroad -- number of articles published abroad by the scientists from a particular country. This number was obtained by searching on the "Institution" field. For example, the number of articles published abroad, by Hungarian scientists, in 1990, will be obtained by performing the following search:

1. > hungary.in. NOT hungary.cp.
2. > ..l/1 yr=90

National lg -- number of articles published in the national language(s) of a country. This number was obtained by searching the language field. For example, the number of articles published in the Hungarian language, in 1990, will be retrieved by performing the following search:

1. > hun.lg.
2. > ..l/1 yr=90

Foreign lg -- number of articles published in a particular country, but in foreign languages. This number was obtained by performing a combined search (using the NOT operator) on both the

name of the country (in the "Country of publication" field) and the three letter code for the national language(s) of the same country. For example, the number of articles that appeared in a foreign language and were published in Hungary, in 1990, will be retrieved by performing the following search:

1. > hungary.cp. NOT hun.lg.
2. > ..l/1 yr=90

CHAPTER V. RESULTS AND DISCUSSION

Table 1 summarizes the results obtained for output in the biomedical field of the Eastern European countries included in this study.

Table 1. Distribution of publications of Eastern European countries by indicator (n -- normalized by the number of inhabitants of the country).

Year	Total	Total(n)	Country	Country(n)	Abroad	Abroad(n)	National	lg National	lg(n)
Bulgaria (population 8.775 million)									
1989	700	80	689	79	81	9	606	69	
1990	635	72	613	70	86	10	529	60	
1991	443	50	359	41	114	13	285	32	
1992	210	24	113	13	105	12	74	8	
1993	353	40	285	32	96	11	230	26	
1994	295	34	198	23	99	11	147	17	
1995	417	48	281	32	138	16	213	24	
Czechoslovakia (population 15.86 million)									
1989	2452	155	2981	188	322	20	1971	124	
1990	2585	163	3019	190	321	20	2038	128	
1991	1608	101	2032	128	330	21	1180	74	
1992	1669	105	1875	118	323	20	1184	75	
1993	1798	113	1889	119	353	22	1251	79	
1994	1516	96	1541	97	400	25	915	58	
1995	1502	95	1290	81	433	27	921	58	
Hungary (population 10.32 million)									
1989	1275	124	1185	115	499	48	573	56	
1990	1411	137	1234	120	535	52	556	54	
1991	1200	116	1006	97	471	46	500	48	
1992	1262	122	1013	98	534	52	538	52	
1993	1086	105	840	81	494	48	487	47	
1994	1087	105	875	85	474	46	460	45	
1995	982	95	673	65	498	48	396	38	
Poland (population 38.8 million)									
1989	3028	78	2882	74	650	17	2249	58	
1990	2881	74	2451	63	754	19	1889	49	
1991	2461	63	2047	53	710	18	1487	38	
1992	2958	76	2771	71	634	16	2027	52	
1993	3048	79	2731	70	667	17	2007	52	
1994	2779	72	2576	66	619	16	1808	47	
1995	2509	65	1913	49	808	21	1434	37	
Romania (population 23.2 million)									
1989	711	31	907	39	38	2	587	25	
1990	477	21	543	23	36	2	287	12	
1991	354	15	375	16	52	2	190	8	
1992	434	19	478	21	36	2	277	12	
1993	368	16	408	18	44	2	186	8	
1994	239	10	246	11	37	2	118	5	
1995	263	11	232	10	55	2	158	7	

Table 2 shows the values of similar indicators for three other European countries, which were included in the study for "normalization" purposes (e.g., Finland, the Netherlands, and Sweden).

Table 2. Distribution of publications of control countries by indicator.

Year	Total	Total(n)	Country	Country (n)	Abroad	Abroad(n)	National	lg National	lg(n)
Finland (population 5.09)									
1989	2343	460	647	127	1919	377	351	69	
1990	2503	492	623	122	2066	406	352	69	
1991	2733	537	1050	206	2149	422	408	80	
1992	2704	531	792	156	2240	440	354	70	
1993	2808	552	695	137	2343	460	372	73	
1994	2923	574	543	107	2505	492	332	65	
1995	2641	519	295	58	2467	485	133	26	
The Netherlands (population 15.5 million)									
1989	6494	419	18425	1189	4332	279	1218	79	
1990	7006	452	20222	1305	4922	318	1220	79	
1991	7201	465	21011	1356	5010	323	1186	77	
1992	7561	488	22299	1439	5386	347	1132	73	
1993	7874	508	20020	1292	5943	383	1105	71	
1994	7843	506	19174	1237	6047	390	969	63	
1995	7860	507	18191	1174	6287	406	830	54	
Sweden (population 8.822 million)									
1989	6412	727	3597	408	4645	527	1102	125	
1990	6722	762	3460	392	5024	569	1017	115	
1991	6757	766	3784	429	4913	557	1161	132	
1992	6490	736	2671	303	5038	571	1045	118	
1993	6545	742	2496	283	5175	587	1055	120	
1994	6566	744	1789	203	5383	610	943	107	
1995	6615	750	1736	197	5503	624	912	103	

In order to better understand the trends in the scientific activities and publication patterns of the scientists from Eastern Europe, the data for each individual country are presented graphically, in an uniform way (Figures 1-5). Figures 6-8 present data, obtained in a similar way, for the control countries (i.e., Finland, the Netherlands, and Sweden).

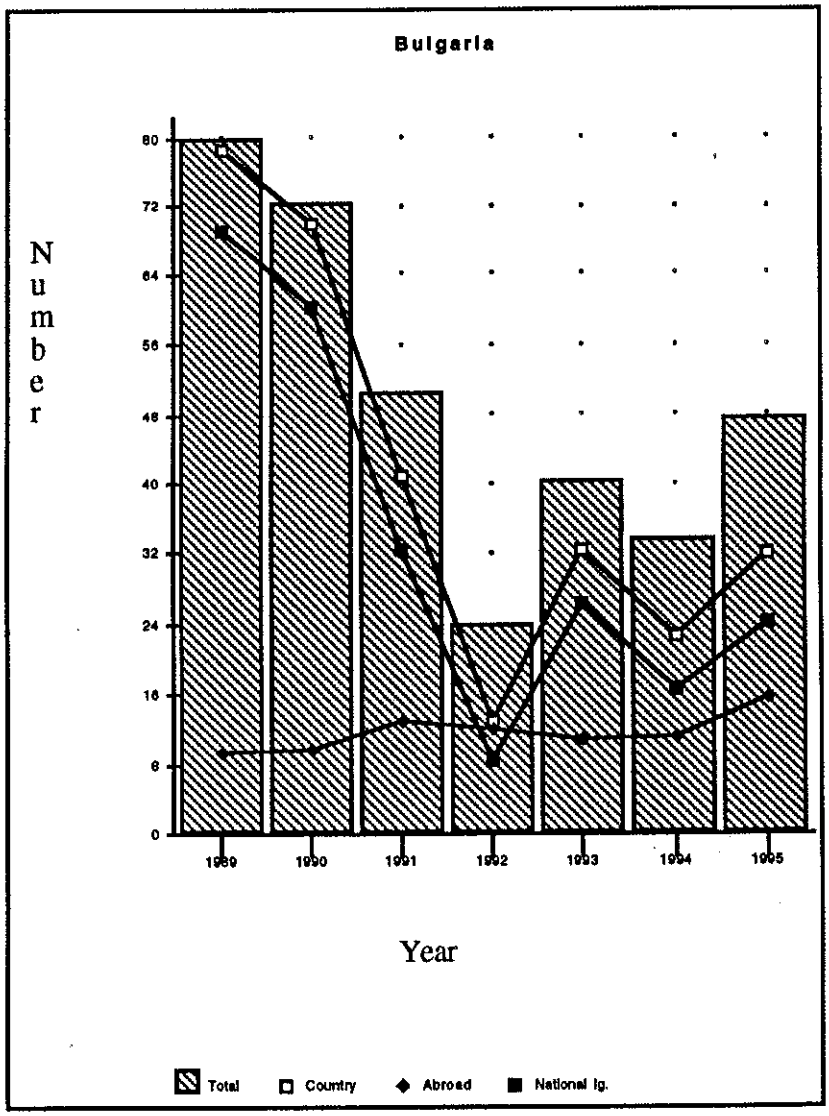


Fig. 1. Bulgaria. Distribution of articles by indicator.
Total, total number of articles published by Bulgarian scientists.
Country, total number of articles published in Bulgaria;
Abroad, number of articles published by Bulgarian scientists abroad;
National lg., number of articles published in the national language of the country.

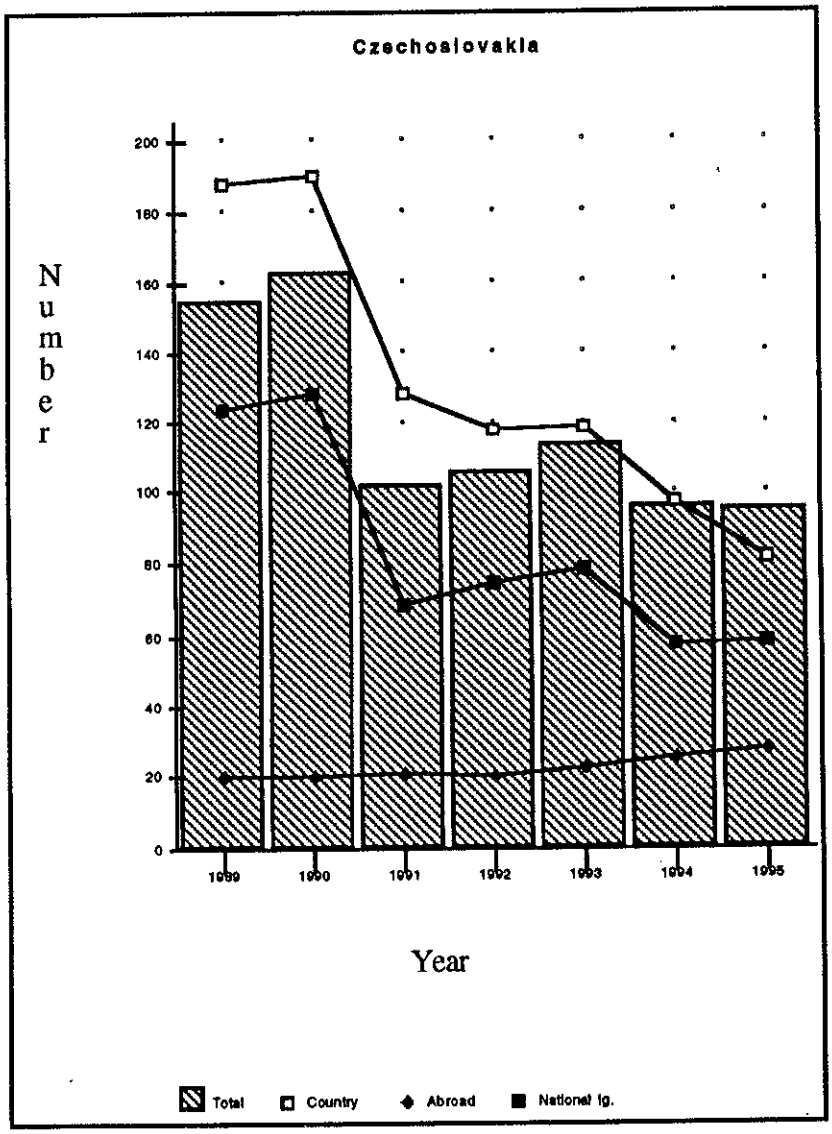


Fig. 2. Czechoslovakia (former Czechoslovakia, the Czech Republic and Slovakia combined)
Distribution of articles by indicator.
Total, total number of articles published by Czech and Slovak scientists.
Country, total number of articles published in Czecholsovakia;
Abroad, number of articles published by Czech and Slovak scientists abroad;
National lg., number of articles published in the national languages of the country.

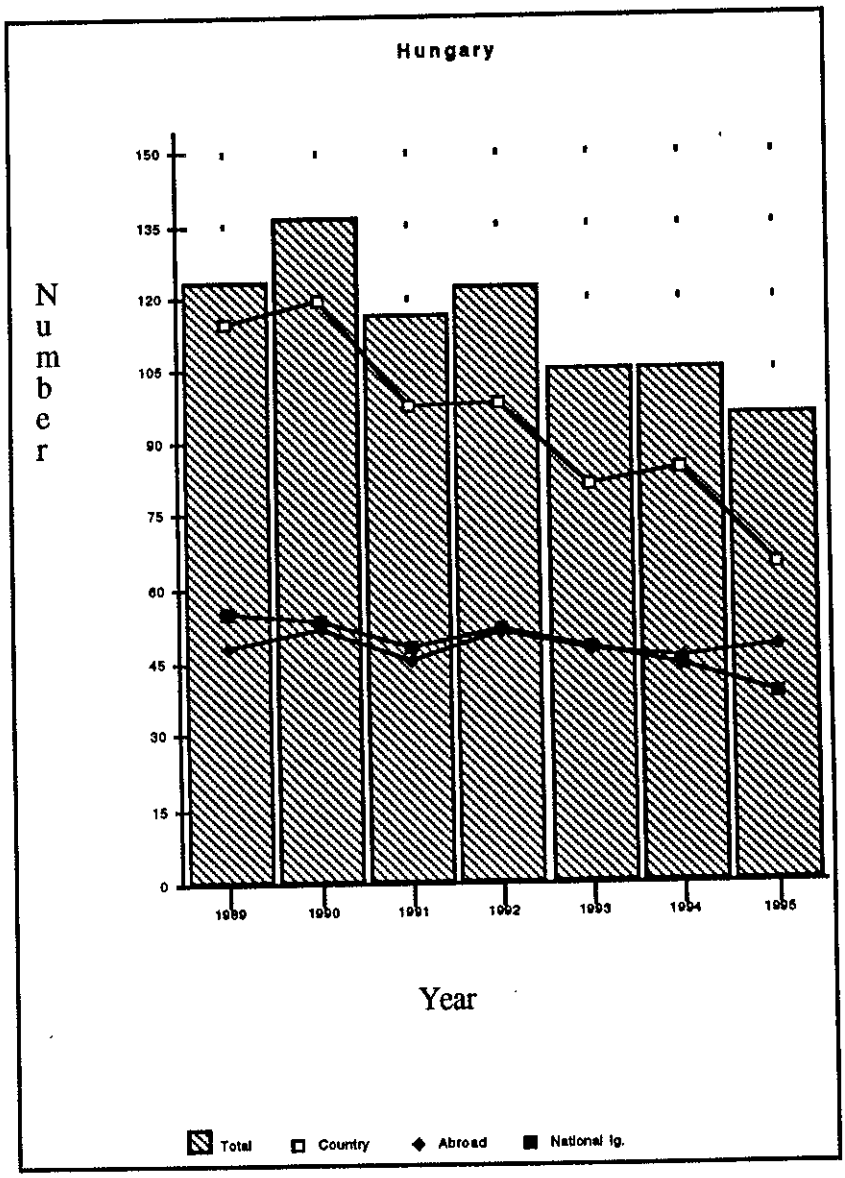


Fig. 3. Hungary. Distribution of articles by indicator.
Total, total number of articles published by Hungarian scientists.
Country, total number of articles published in Hungary;
Abroad, number of articles published by Hungarian scientists abroad;
National lg., number of articles published in the national language of the country.

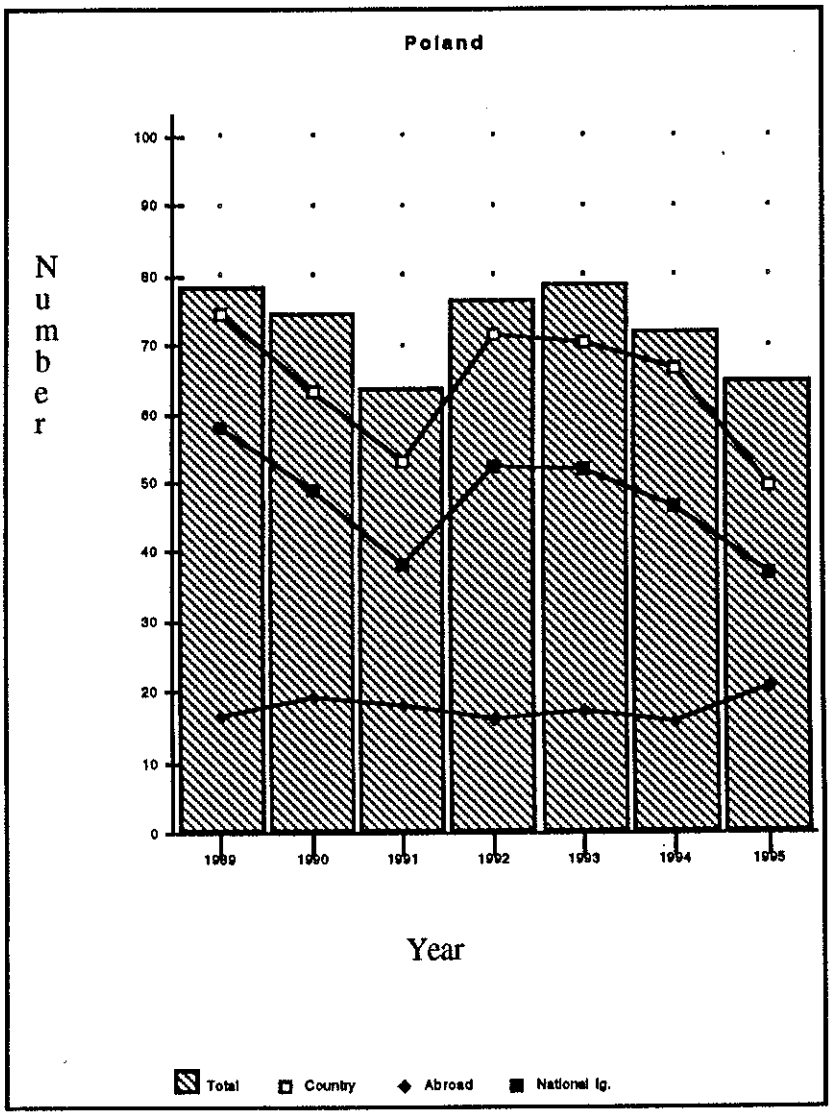


Fig. 4. Poland. Distribution of articles by indicator.
Total, total number of articles published by Polish scientists.
Country, total number of articles published in Poland;
Abroad, number of articles published by Polish scientists abroad;
National lg., number of articles published in the national language of the country.

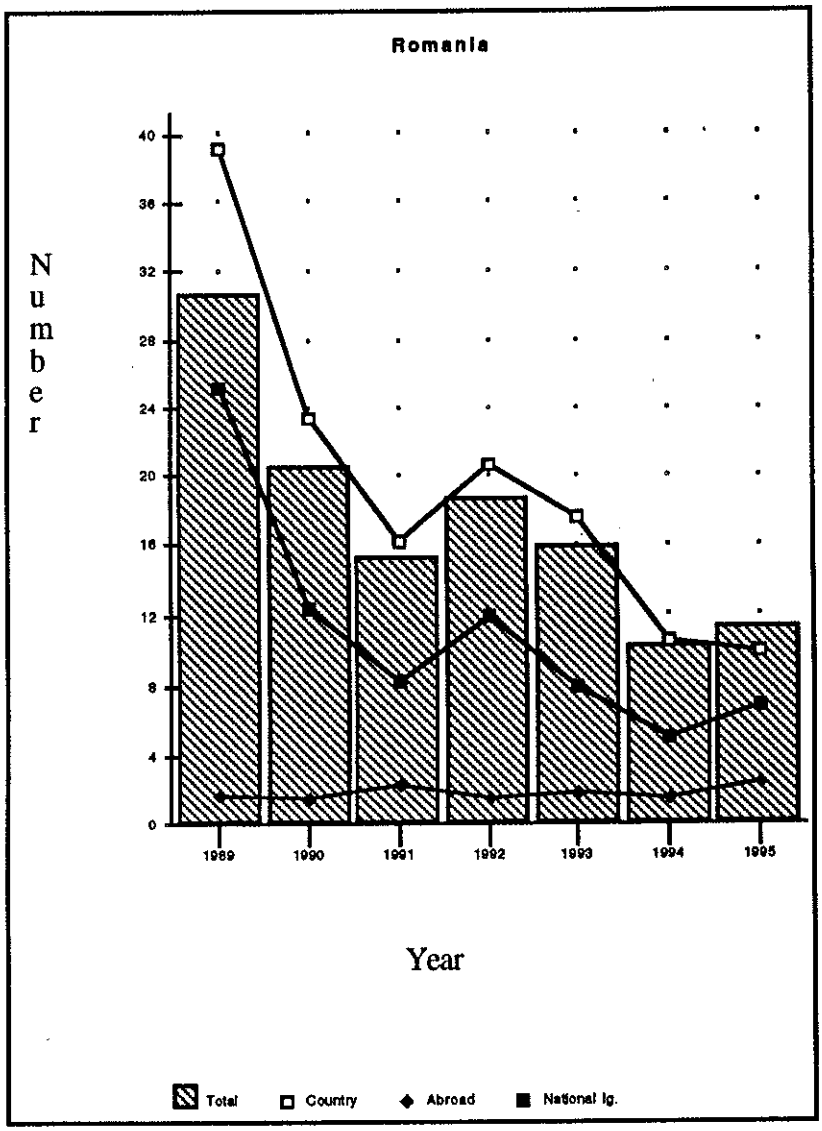


Fig. 5. Romania. Distribution of articles by indicator.
Total, total number of articles published by Romanian scientists.
Country, total number of articles published in Romania;
Abroad, number of articles published by Romanian scientists abroad;
National lg., number of articles published in the national language of the country.

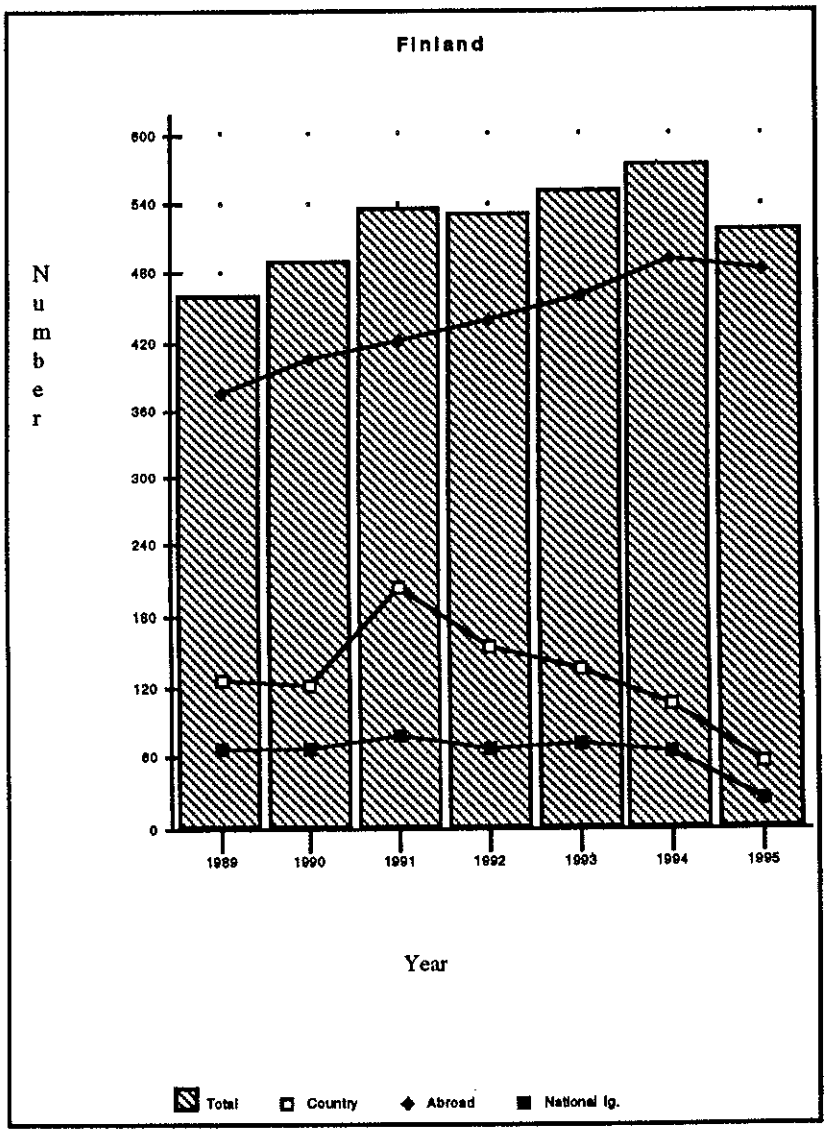


Fig. 6. Finland. Distribution of articles by indicator.
Total, total number of articles published by Finish scientists;
Country, total number of articles published in Finland;
Abroad, number of articles published by Finish scientists abroad;
National lg., number of articles published in the national language of the country.

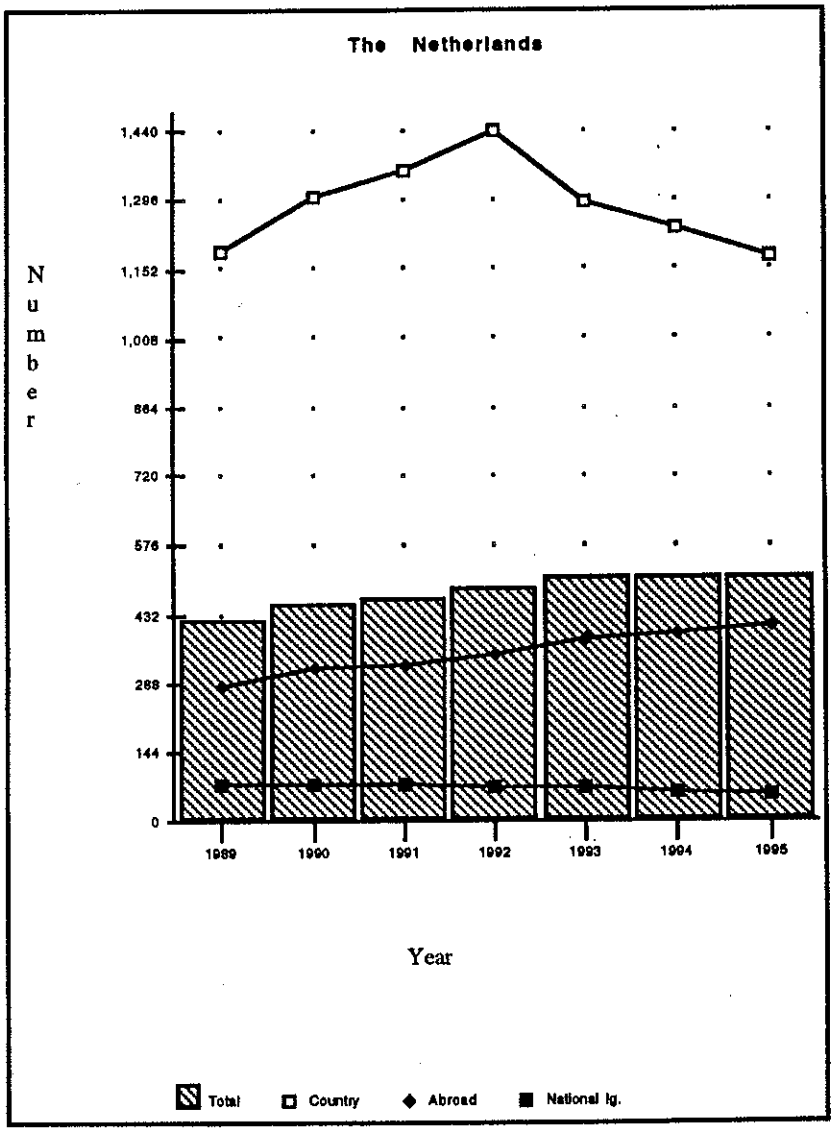


Fig. 7. The Netherlands. Distribution of articles by indicator.
Total, total number of articles published by Dutch scientists;
Country, total number of articles published in the Netherlands;
Abroad, number of articles published by Dutch scientists abroad;
National lg., number of articles published in the national language of the country.

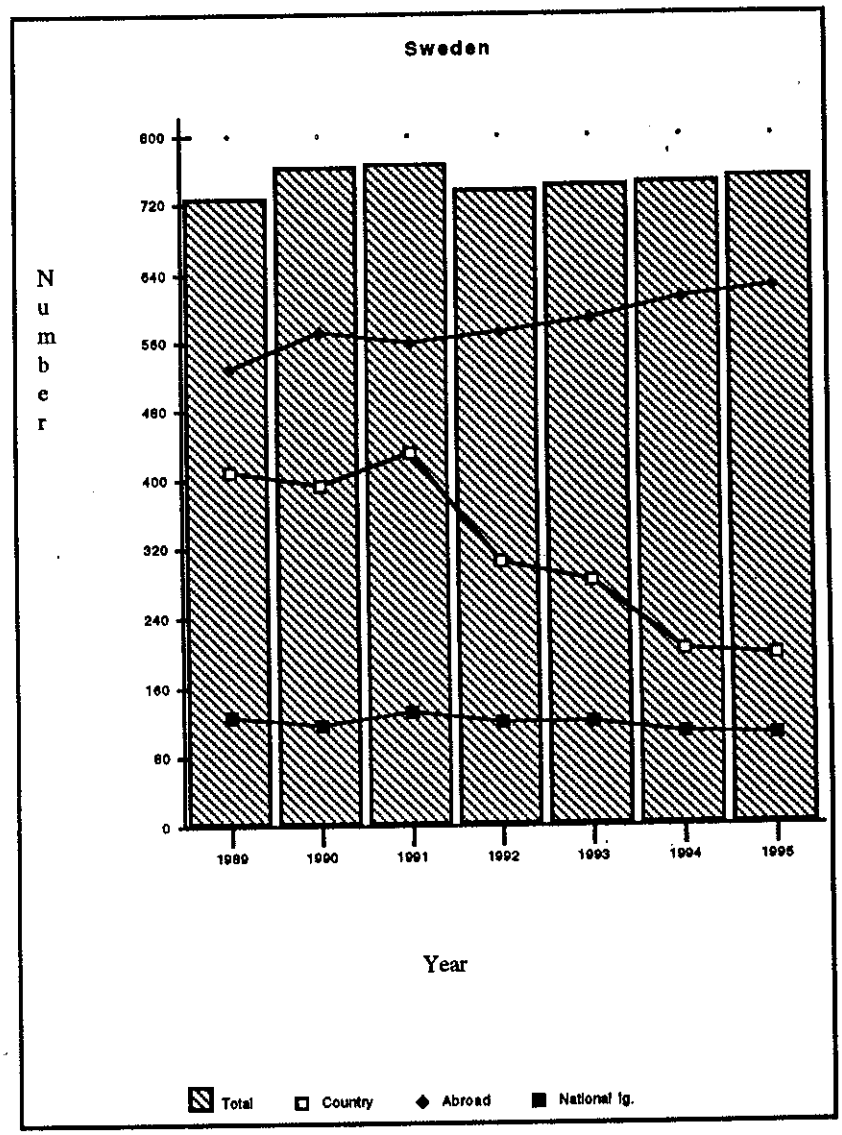


Fig. 8. Sweden. Distribution of articles by indicator.
Total, total number of articles published by Swedish scientists;
Country, total number of articles published in Sweden;
Abroad, number of articles published by Swedish scientists abroad;
National lg., number of articles published in the national language of the country.

The results show that for all **Eastern European countries** included in the study the number of articles published inside the country decreased after 1990, reaching a minimum in 1991 (Czechoslovakia, Hungary, Poland, and Romania) or 1992 (Bulgaria) (Fig. 1-5). In 1991-1992, the articles published in the other three (control) European countries increased (Fig. 6- 8).

The total number of articles published by scientists from individual countries is shown in Figures 1-8. The significant decline observed in the number of articles published by Bulgarian and Roumanian scientists, as well as by those from the former Czechoslovakia (Fig. 1, 2, and 5) was the most pronounced in 1991 or 1992, while, in the case of the production by Hungarian and Polish scientists, the decrease was gradual and not so dramatic. This could be explained by the fact that Hungary and Poland started the political and economic reforms before this process began in 1989, in the other three countries (i.e., Bulgaria, Czechoslovakia, and Romania).

The relative stability of the scientific production in Hungary and Poland could also be attributed to the financial support that the Soros Foundation is devoting to these countries, in general, and to the biomedical research there, in particular (The Foundation Directory, 1996). During the same time period, the scientific production by Finish (Fig. 6) and Dutch (Fig. 7) scientists increased, while that of Swedish scientists (Fig. 8) remained almost the same.

Table 3 shows the distribution of publications by Eastern European scientists by indicator, in percentage shares. For Bulgaria, Czechoslovakia, Poland, and Romania, the percentage share of publications in the national languages of the countries decreased. In Hungary, it remained almost the same, but it was the lowest among the Eastern European countries included in this study. The percentage share of articles published abroad increased for all Eastern European countries. The number of articles published in a foreign language in Bulgaria, Czechoslovakia, Poland, and Romania increased, while in Hungary this indicator decreased.

Table 3. Distribution of publications by Eastern European scientists by indicator (in % of the total number of publications).

	Year	Abroad	Published in the country, in: National lg	Foreign lg
Bulgaria				
	1989	12	87	2
	1990	14	83	3
	1991	26	64	10
	1992	50	35	15
	1993	27	65	8
	1994	34	50	17
	1995	33	51	16
Czechoslovakia + Czech Republic + Slovakia				
	1989	13	80	6
	1990	12	79	9
	1991	21	67	12
	1992	19	71	10
	1993	20	69	11
	1994	26	60	13
	1995	29	61	10
Hungary				
	1989	39	45	16
	1990	38	39	23
	1991	39	42	19
	1992	42	43	15
	1993	45	46	9
	1994	44	42	14
	1995	51	40	9
Poland				
	1989	21	74	4
	1990	26	65	8
	1991	29	60	11
	1992	21	69	10
	1993	22	66	12
	1994	22	65	13
	1995	32	57	11
Romania				
	1989	5	83	12
	1990	8	60	32
	1991	15	54	32
	1992	8	64	28
	1993	12	51	38
	1994	15	49	35
	1995	21	60	19

Table 4 shows the distribution of publications by scientists from the control countries by indicator, in percentage shares. In Finland, the Netherlands, and Sweden, the number of articles published abroad increased, while the number of articles published in these countries, in the national languages or in foreign languages, decreased.

Table 4. Distribution of publications by scientists from control countries (in % of the total number of publications)

		Published in the country, in:	
Year	Abroad	National lg	Foreign lg
Finland			
1989	82	15	3
1990	83	14	3
1991	79	15	6
1992	83	13	4
1993	83	13	3
1994	86	11	3
1995	93	5	2
The Netherlands			
1989	67	19	15
1990	70	17	12
1991	70	16	14
1992	71	15	14
1993	75	14	10
1994	77	12	11
1995	80	11	9
Sweden			
1989	72	17	10
1990	75	15	10
1991	73	17	10
1992	78	16	6
1993	79	16	5
1994	82	14	4
1995	83	14	3

It is worth mentioning an observation that was made and might be helpful to those who are searching for publications from a particular country on the MEDLINE database. While performing the searches for this study, it was found that the national journals did not usually spell out the name of the country in the first author's address (MEDLINE field, Institution). Only in the papers published abroad, or in international journals published in this country, the name of the country could be found in the address. With very few exceptions (e.g., one national Polish and one

Finnish journals, both being published in the national languages of these countries, started including the name of the country in the author's institutional address). For all other countries included in this study, this rule was valid (e.g., if a search is performed on the name of the country, in the Institution field, and this search is combined, using the AND operator, with a search performed on the national language field, no documents will be retrieved). For example, searching under "bulgaria.in. AND bul.lg." will retrieve no documents at all.

In a previously discussed paper, Braun and Schubert (1996) concluded that there were no signs of dramatic changes in the output in the life sciences, chemistry, physics, engineering, and mathematics, in the Czech Republic, Hungary, and Slovakia. The results presented in this paper are in obvious disagreement with the findings reported here. In the present study, the total output of these countries showed a significant decrease (particularly, in 1991 and 1992), which parallels the decrease in the number of publications in the national languages of these countries. It is not surprising that Braun and Schubert did not find differences in the total output of these Eastern European countries, during a period of time (i.e., 1990-1994) which falls into the time limits of the present study. They had used the *SCI* database to perform their study, which covers a limited number of foreign non-English national journals, and their results represent mainly articles published abroad by scientists from the above mentioned Eastern European countries. In the present study, the number of articles published abroad by Eastern European scientists also remained almost the same during the 1989-1995 time period.

The results obtained in the present study show that the political, economic, and social changes that occurred in Eastern Europe after 1989 appear to have had a dramatic impact on the level of scientific productivity of the scientists in the region. By comparing the results obtained for the Eastern European countries with those found for three other European countries, which have not experienced such a transition period, it is possible to conclude that the changes observed in the scientific activities of the Eastern European scientists can be attributed to the transformation through which this region has been going through after 1989. Some other studies have shown that

the international cooperation between the Eastern European countries and the West has significantly increased in the 80s, but in the 90s this process was reverted. Although efforts have been made to save Eastern European science during this difficult economic period, the results from this study show that even in the biomedical field (which is considered, by the local governments, of vital importance for the region) this support has not been sufficient.

The results presented here suggest that the MEDLINE database, because of its broad coverage of national and international biomedical journals, is more suitable for evaluating the output of different countries (especially countries where English is not the national language) than the *SCI* database. Since our goal was to draw an overall picture of processes occurring in biomedical research in Eastern Europe, it was essential to be able to analyze the scientific literature published in the national journals of these countries. There are areas of research, particularly in the more applied fields, that are important from national viewpoint, and which do not merit publishing the results from such research in international journals. Also, national researchers have an obligation to provide access to their research in their own country and language, especially given the more limited access now to international journals in these countries. For a long time, publishing in western journals was difficult for Eastern European scientists, because of the isolation of these countries from the rest of the world. Thus, evaluation of national output of these countries, without taking into consideration the articles published in the national journals, would give an incomplete and even misleading picture of the situation in the sciences in these countries.

In conclusion, our data show that there was a consistent decrease in the total output of the countries in Eastern Europe after 1990, while those published by scientists from other European countries either increased, or remained almost the same. For both groups of countries studied here (with the notable exception of The Netherlands, in the control group), a drop in the number of articles published in each individual country was observed. It is quite possible that the publication of many international scientific journals in The Netherlands could account for this exception.

The results from this study demonstrate that Eastern European biomedical research needs a more significant support by both the local governments and the whole international community, because the existing environmental problems and their adverse effects on human health can affect other European countries as well. The methodology developed during this investigation represents a basis for expanding this study to target specific areas of biomedical science, such as cancer research, for example. Focusing on particular biomedical areas will provide a more specific information about the similarities and differences between the Eastern European countries and what contributions they have made in these areas.

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