



COMMISSION OF THE EUROPEAN COMMUNITIES

Brussels, 18 January 2000
COM (2000) 6

**COMMUNICATION FROM THE COMMISSION TO THE COUNCIL, THE
EUROPEAN PARLIAMENT, THE ECONOMIC AND SOCIAL COMMITTEE AND
THE COMMITTEE OF THE REGIONS**

Towards a European research area

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Towards a European research area

SITUATION AND OBJECTIVES

1. RESEARCH IN EUROPE

Even more so than the century that has just finished the XXIst century we are now entering will be the century of science and technology. More than ever, investing in research and technological development offers the most promise for the future.

In Europe, however, the situation concerning research is worrying. Without concerted action to rectify this the current trend could lead to a loss of growth and competitiveness in an increasingly global economy. The leeway to be made up on the other technological powers in the world will grow still further. And Europe might not successfully achieve the transition to a knowledge-based economy.

Why such a negative picture?¹

- The average research effort in the Union (the differences being significant from one country to another) is currently only 1.8% of Europe's GDP, as against 2.8% in the United States and 2.9% in Japan.²
- What is more, this gap seems to be on the increase. The difference between total public and private expenditure on research in the US and Europe amounted to some EUR 60 billion in 1998, as against 12 billion in 1992.³
- In terms of employment researchers account for only 2.5 in every thousand of the industrial workforce in Europe, as against 6.7‰ in the United States and 6‰ in Japan.
- The trade balance in high tech products has thus shown a deficit of EUR 20 billion per year in Europe over the past ten years, and this deficit seems to be increasing.
- The number of degree-level European students in the United States is twice as high as the number of American students at that level in Europe,⁴ and 50% of Europeans studying for a doctorate in the United States stay there for long periods, sometimes for ever.

¹ The figures given in this Communication are illustrated and completed in the tables and graphs in Annex II.

² Research DG/Eurostat estimate for 1998.

³ Research DG estimate based on Eurostat and OECD data.

⁴ Second European report on scientific and technological indicators, 1997.

- However, research and technology account for 25 to 50% of economic growth and have a strong influence on competitiveness and employment and the quality of life of Europeans.
- If technological progress creates the jobs of tomorrow, it is research which creates the jobs of the day after tomorrow. The current trends in research could therefore have a negative influence on the development of employment in Europe in the years ahead.

Europe is not only investing less and less of its richness in progress in knowledge, the image that Europeans have of science is also less positive than it was. Scientific progress seems to inspire as much anguish as hope, and the gap between the scientific world and the people at large is growing.

Yet Europe produces a third of the world's scientific knowledge. It is in the forefront in areas such as medical research and chemistry. And it has had notable success stories in technology, in sectors such as aeronautics and telecommunications. This potential must be maintained, increased and fully exploited.

It is time therefore for an in-depth debate to define a policy approach in order to reinvigorate research in Europe.

2. BETTER INVESTMENT IN KNOWLEDGE

In the final years of the XXth century we entered a knowledge-based society. Economic and social development will depend essentially on knowledge in its different forms, on the production, acquisition and use of knowledge.

Scientific research and technological development more particularly are at the heart of what makes society tick. More and more, activities undertaken in this domain are for the express purpose of meeting a social demand and satisfying social needs, especially in connection with the evolution of work and the emergence of new ways of life and activities.

By creating new products, processes and markets research and technology provide one of the principal driving forces of economic growth, competitiveness and employment. They are the best way of modernising European companies, which Europe must do to improve its competitive position. In overall terms, both directly and indirectly, they help to maintain and develop employment. By way of example:

- Just the European market in products arising out of biotechnology, which at present amounts to around EUR 60 billion per year, should expand to EUR 250 billion over the next five years.
- A good many of the two million jobs that have been created each year in the United States since 1991 have been in high tech sectors, particularly in SMEs with high growth potential
- It is in industries with high research and development intensity, such as pharmaceuticals, aeronautics or biology, that jobs have been best maintained and even increased.

- And it is in the European regions where the business research effort is at its greatest that the lowest unemployment rates tend to be found.

The European Council has stressed on several occasions in recent years the importance of sustained research and technological development for growth and employment. It will look further into this issue at the Special European Council in Lisbon in March entitled "Employment, economic reform and social cohesion - Towards a Europe of innovation and knowledge". The European Parliament, for its part, has often drawn attention to the need for Europe to increase investment in science and technology.

3. PUBLIC RESEARCH EFFORT

Research plays a central role in the implementation of public policy and is also at the heart of the policy-making process. In areas such as health, sustainable development or industrial, food and nuclear safety, policy options and decisions must be based on more solid scientific knowledge and a full and proper understanding of the economic and social aspects surrounding the problems in question.

Basic research is now carried out in various institutional frameworks: universities, research institutes, companies and consortia of each. In some cases it can be translated fairly rapidly into concrete applications. This has been the case, for example, with breakthroughs in molecular biology and immunology in the field of health. It can also give rise to unexpected applications years later in fields somewhat removed from the ones they started out in .

In the United States the major basic research agencies have kept up and even increased their research effort in recent years. And Japan, eager to make up the leeway, has constantly increased its efforts in this area . Europe would be quite wrong to reduce its investment in this area. Science is after all and always has been one of the biggest and most exciting adventures of the human spirit. It is the product of a creativity which must not disappear in the Europe of the 21st century.

4. PRIVATE INVESTMENT

The private sector finances more than half and carries out two thirds of Europe's research and technological development activities. Private investment in research and development in Europe, which had dipped, has picked up again in recent years. Investment by international and multinational concerns in Europe has maintained at a high level and even increased. Because of the globalisation of the economy, together with the industrial and technological alliances and mergers and acquisitions that are mushrooming in every sector, these companies are developing research and development strategies on an international scale. For some of the private sector research is thus increasingly at European and even world level.

That said, the global increase in expenditure on research and development in the private sector is less than it has been amongst its main competitors in the United States and Asia. Basically, this due to the somewhat limited research effort of medium sized businesses and small enterprises. In Europe the latter are made up essentially of companies that do or could use technology and whose future depends on the development of their technological capacities. But only a limited number of small businesses are exploiting the potential of high technology, and the creation of companies commercialising the results of research and development is still on the low side in Europe.

On the other hand, the European financial market has not yet sufficiently discovered the economic value of investment in knowledge. While it has now started to increase, the volume of risk capital being channelled into innovation is still limited in Europe. Investment of this type of capital in high tech sectors and in the creation of companies is much lower than in the United States. By and large, the climate for private investment into research in Europe needs to be improved.

5. ORGANISATION OF RESEARCH IN EUROPE

The Treaty provides the European Union with a legal basis for measures to help to support European cooperation in research and technological development.

However, the principal reference framework for research activities in Europe is national. Funding of the various initiatives of European, Community or intergovernmental scientific and technological cooperation does not exceed 17% of the total public expenditure on European research.

The principal instrument used so far in Europe is the European Union's framework programme for research. In financial terms, however, it accounts for only about 5.4% of the total public effort. While it is a useful instrument for promoting international cooperation, it alone does not able the achievement of a better organisation of the European research effort.

Above the European research effort as it stands today is no more than the simple addition of the efforts of the 15 Member States and the Union. This fragmentation, isolation and compartmentalisation of national research efforts and systems and the disparity of regulatory and administrative systems only serve to compound the impact of lower global investment in knowledge.

Decomartmentalisation and better integration of Europe's scientific and technological area is an indispensable condition for invigorating research in Europe. We need to go beyond the current static structure of "15+1" towards a more dynamic configuration. This has to be based on a more coherent approach involving measures taken at different levels: by the Member States at national level, by the European Union with the framework programme and other possible instruments, and by intergovernmental cooperation organisations. A configuration of this kind would make for the essential "critical mass" in the major areas of progress in knowledge, in particular to achieve economies of scale, to allocate resources better overall, and to reduce negative externalities due to insufficient mobility of factors and poor information for operators.

The European market of supply and demand in knowledge and technology still remains largely to be created. For it to develop and function a real European research policy needs to be defined.

6. A REAL EUROPEAN POLICY: TOWARDS A EUROPEAN RESEARCH AREA

It cannot be said that there is today a European policy on research. National research policies and Union policy overlap without forming a coherent whole. If more progress is to be made a broader approach is needed than the one adopted to date. The forthcoming enlargement of the Union will only increase this need. It opens the prospect of a Europe of 25 or 30 countries which will not be able to operate with the methods used so far.

This issue was at the centre of the informal meeting of research ministers of 20 May 1999, which provided the opportunity for a discussion on the subject with experts from the scientific community. This interest was confirmed at the Research Council of 2 December 1999. The European Parliament, for its part, has, for several years, has been looking increasingly at the problem of what shape to give to the Union's research effort.

The aim of this communication is to look at how to progress towards a better organisation of research in Europe and to put forward suggestions for consideration and debate. The idea is to create a European research area. This is not a new idea, but the conditions required to progress towards achieving this now seem to be in place.

How should this idea of a European research area be defined? It should embrace in particular the following aspects:

- Networking of existing centres of excellence in Europe and the creation of virtual centres through the use of new interactive communication tools.
- A common approach to the needs and means of financing large research facilities in Europe.
- More coherent implementation of national and European research activities and closer relations between the various organisations of scientific and technological cooperation in Europe.
- Better use of instruments and resources to encourage investment in research and innovation: systems of indirect aid (within the Community rules on State aid), patents, risk capital.
- Establishment of a common system of scientific and technical reference for the implementation of policies.
- More abundant and more mobile human resources:
 - Greater mobility of researchers and introduction of a European dimension to scientific careers.
 - More prominence to the place and role of women in research.
 - Stimulating young people's taste for research and careers in science.
- Greater European cohesion in research based on the best experiences of knowledge transfer at regional and local levels and on the role of the regions in the European research efforts.
- Bringing together the scientific communities, companies and researchers of Western and Eastern Europe.
- Improving the attraction of Europe for researchers from the rest of the world.
- Promotion of common social and ethical values in scientific and technological matters.

Issues that have so far not been properly tackled should be re-examined. The question of launching "variable geometry" programmes and actions at European level, for example, and

the shape that these should take comes into sharper focus once more with the prospect of a Europe soon to be enlarged to 25 or 30 countries. The possibilities in this area within the Treaty should be looked at once more.

In the same way, the question of “dual use research” needs to be looked at more deeply. In areas such as aeronautics, advanced materials or information technologies and communications, numerous research projects can give rise to applications in both the civil and the defence sector.

In its two communications on the defence industry in 1996 and 1997,⁵ the Commission underlined the possibility of maximising the synergy between these two sectors and the need to improve complementarity between the programmes undertaken in Europe in this field. The progress achieved following the European Council in Cologne towards a Common Foreign and Security Policy (CFSP) puts this matter in a new light and calls for an in-depth debate on the subject.

Essentially, the non-existence of a European research area is due to the compartmentalisation of public research systems and to the lack of coordination in the manner in which national and European research policies are implemented. Much needs to be done in this area, without, however, putting unwieldy mechanisms in place. At the same time the barriers must be lifted between different disciplines, along with the barriers that curb the movement of knowledge and persons between the academic and the business worlds.

Even if most of the measures need to be taken by the public authorities, the measures proposed will have an impact on the whole research system (public and private). Centres of excellence will produce knowledge that can be used by companies, which are also among the users of research facilities. And improved systems of indirect support for research and innovation also concern the private sector.

⁵ COM(96)10 and COM(97)583.

A EUROPEAN RESEARCH AREA⁶

1. A STOCK OF MATERIAL RESOURCES AND FACILITIES OPTIMISED AT THE EUROPEAN LEVEL

1.1. Networking of centres of excellence and creation of virtual centres

World class centres of excellence exist in practically all areas and disciplines in Europe. Their exact specialities, however, are not always sufficiently well known outside the frontiers of the country in which they are established, especially by companies, which could usefully join forces with them. One of the criteria generally used to define the centres of excellence is their capacity to produce knowledge that can be used for industrial purposes.

Many problems of basic and applied research also need both a critical mass of financial and human resources and the combination of complementary expertise from specialists in other domains.

Mapping of European centres of excellence would make for better transparency in this area. A very high level of performance could also be achieved by the networking of specialist centres throughout the countries of the Union. The forms of teleworking which electronic networks permit make it possible to create real “virtual centres of excellence”, in particular multidisciplinary and involving universities and companies.

To promote excellence, however, it is also necessary to ensure a sufficient level of competition between private and public research operators. Schemes to finance centres of excellence on the basis of competition have been put in place in several Member States. This formula could be applied to the European level, with collaboration between the Commission and the Member States.

1.2. Defining a European approach to research infrastructures

Research infrastructures play a central role in the progress and application of knowledge in Europe. Radiation sources, computer centres and databases on molecular biology, for example, are operated increasingly by research teams from the public and private sectors. Facilities of this kind exist in all the Member States. Construction costs are high, often beyond the capacities of a single country, as are operating costs. And their potential is not always maximised.

Large-scale infrastructures have been constructed and are now being operated at European level. Furthermore, assessment of the need for new facilities is often made in a bilateral or multilateral framework. For its part, the European Union, has, for several years, been operating a programme of support for research infrastructures. So far measures within this framework have been restricted to providing support for transnational access to facilities, for the development of new instruments and equipment and for cooperation projects designed to improve the interoperability of installations and the complementarity of their activities.

What should be done now is to go a step further and develop a European approach to infrastructures, covering both the creation of new installations, the functioning of existing

⁶ The list of possible themes for action is contained in Annex I.

ones and access to them. An analysis of responsibilities (notably financial) on these three fronts should be made and plans to combine measures and means defined. Following on from the work carried out by the European Science Foundation (ESF) and the OECD, an accurate assessment should also be made of the needs to be covered at European level (including joint services).

A conference on the subject of research facilities in Europe will be organised in Strasbourg in the second half of the year 2000 by the Commission in conjunction with the European Science Foundation. This could provide the occasion for putting in place a framework in which to discuss these issues.

1.3. Better use of the potential offered by electronic networks

Electronic networks open up every new possibility of work to researchers: virtual laboratories; remote operation of instruments; quasi-unlimited access to complex databases. Created for the use of the scientific community, the Internet has also become the medium for multiple information and communication activities and has given rise to spectacular commercial developments. The World Wide Web, which was developed by a CERN researcher to cover the needs of physicists, is now used by tens of millions of people.

To meet the particular needs of research, which are constantly on the increase, specific networks are necessary. In the United States, broadband, high-speed facilities are now available to researchers, especially at universities. The recent Internet-2 and Next Generation Internet (NGI) initiatives launched in partnership by the scientific community, the public authorities and the private sector in the United States should increase these capacities even further.

To reduce the disparities in Europe in this area the Union is supporting an interconnection project of national telematics networks at progressively larger capacity levels: 34 Mbits/s, 155 Mbits/s now, and soon 622 Mbits/s, the ultimate objective being to achieve the order of magnitude of Gbits/s, at which some connections already operate in the United States.

To help Europe catch up quicker where electronic networks are concerned, the Commission proposed an e-Europe initiative at the Helsinki Summit, which sets ambitious objectives in terms in particular of interconnection at European level. It is accompanied by a timetable through to 2005. One of the aims is to promote maximum use of these networks by the community of researchers.

To increase the productivity of European research while helping to structure collaboration on a continental scale action will have to be taken in this context to encourage the use of electronic networks in the various fields of research in European as well as national research programmes: development of databases and access to advanced Internet services; promotion of the production of multimedia content and interactive uses; support for new forms of electronic collaboration of researchers ahead of the emergence of real “virtual research institutes”.

At the same time it will be necessary to encourage researcher awareness-building and training campaigns at national and European levels on the possibilities created by information technologies and communications.

These organisations play an important role on Europe's science and technology scene. They are now facing common problems (financing, integration of researchers from central and eastern European countries, dialogue with the United States). It would be useful to provide them with a framework in which they could discuss their respective roles on the European scientific and technological scene and their relations between one another and with the Union.

Priority must be given to establishing the conditions for political consultation between these organisations. This could be achieved by way of a council of their senior officials meeting at regular intervals. This would also give Europeans and outside observers a more coherent image of the Europe of science and technology.

3. MORE DYNAMIC PRIVATE INVESTMENT

3.1. Better use of instruments or indirect support to research

Increasing use is being made in the world of instruments for indirect support, especially fiscal measures, in order to stimulate private investment in research and development and to create researcher and technician posts in companies. In the United States and Canada, interesting long-term support schemes for start-up companies are in place, for example.

In Europe the mechanisms used in the various countries are very diverse. Some Member States make sustained use of them, others far less.

User-friendly information systems need to be developed on existing mechanisms. The exchange and spread of good practices should also be encouraged in order to stimulate private investment in research, particularly among SMEs, and innovation.

The different situations between countries and regions in this area can affect competition between them in many ways and create conditions that are more, or less, conducive to investment in research and innovation. Where the measures employed have an element of State aid about them, Community rules on State aid should always be respected.

3.2. Development of effective tools to protect intellectual property

The current European system of patents, as operated around the European Patents Office and the national offices, is based on the issue of national patents which are valid only in the Member States in which they are issued. This system is costly and the high cost of patents is broadly believed to be one of the major obstacles to widespread use of patents in Europe. The Commission therefore plans to propose the creation of a standard Community patent to cover all of the European territory. At international level the Commission will endeavour to adapt the TRIPS agreements on intellectual property to new technological developments.

It is important for research in Europe for the European patent to be started up as soon as possible. It must be readily affordable and comparable in cost to a European patent covering a limited number of countries. Efforts need to be made in particular to reduce the costs of translation. The Commission is also keeping a close eye on work carried out by the European Patent Organisation as part of the revision of the Munich Convention in order to see how the effects of disclosures prior to filing can be taken into account by European patent law.

To increase the impact of research efforts undertaken in Europe in terms of innovation, the relevance and consistency of the intellectual property arrangements used to implement public research programmes should also be improved.

The protection of intellectual property can be achieved by other means than patents. In addition to the initiatives taken in the First Action Plan for Innovation in Europe, information systems and systems for exchange of good practices in this field could be put in place by national and European support organisations for research and innovation.

3.3. Encouragement of the creation of companies and risk capital investment

The creation of high tech companies by researchers, or with researchers having a stake in the capital, is still fairly low-key in Europe. Measures taken in recent years at regional level, such as the creation of technology parks and business incubators, or by certain Member States, such as changes in the status of public sector researchers, have had a positive effect in this respect. These could be completed by other initiatives.

Europe also suffers notoriously from too low a level of risk capital investment in high tech sectors. Positive changes have been observed for some time now. Some 650 companies are now quoted on the new European markets (Euro-NM, EASDAQ and AIM). That said, this is eight times fewer than in the United States. In extending the first action plan for innovation in Europe, the Commission has, in recent years, taken a series of initiatives in this area, several of which (e.g. I-TEC project) are being implemented in conjunction with the European Investment Bank (EIB). In 1999 it presented two communications on this subject.⁸ As part of the e-Europe initiative the Commission recently proposed a plan of action designed to establish an inventory by March 2000 of existing instruments at Union level.

Several national research centres and the JRC have joined forces to provide innovative start-up companies with the technical support and expertise they need to develop. Initiatives of this kind need to be stepped up.

Initiatives should also be encouraged to bring scientists, industrialists and financiers at all levels into contact need to be stepped up. This could be achieved in conjunction with the national and European research programmes, preferably on a combined basis. Promising experiments have been completed along these lines, like the "Investment Forum" in the field of information technology and communications and the creation of the "Biotechnology and Finance Forum".

4. A COMMON SYSTEM OF SCIENTIFIC AND TECHNICAL REFERENCE FOR POLICY IMPLEMENTATION

4.1. Developing the research needed for political decisions

Science and technology play an increasingly important role in the implementation of public policies, particularly Union policies. They are involved in various forms in the drafting of regulations and can be found more and more in the policy-making process, at the heart of trade negotiations and at the centre of international discussions in fields such as, for example, safety in its various forms or the various aspects of sustainable development.

⁸ COM (99)232 and COM (99)493.

The European research system must be organised in such a way as to preempt and take account of needs arising at the different stages of implementation of public policies: drafting, decision-taking, implementation, monitoring. Policy-makers must be able to draw on precise knowledge which is as complete as possible and constantly updated and validated.

Accordingly, research directly undertaken by the Commission must tie in with the major concerns of the individual and the decision-makers, such as environmental protection, food safety and chemical products or nuclear safety.

The results of research undertaken as part of European programmes should be systematically exploited in support of the various Union policies and all the Union's research activities better co-ordinated in this respect.

A reliable and recognised system of validating knowledge and methods of analysis, control and certification also needs to be put in place and centres of excellence in Europe in the fields concerned networked.

4.2. Establishment of a common system of scientific and technical reference

When drawing up regulations or when faced with emergency situations, policy-makers, especially at European level, are confronted with complex problems where the stakes are high. Citizens and economic and social operators must be guaranteed greater safety whilst resolving conflicts between categories of actions with often divergent interests. As the Commission underlined in the White paper on food safety,⁹ the Union must re-establish the confidence of the public and consumers in food (the way it is produced, regulated and controlled).

In Europe the way expertise is provided for decision-makers differs according to country and subject matter. Authorities established at European and national levels abound. Experts are also forced to leave the ground of solely scientific consideration. The way they assess the problems and their recommendations bear the imprint of their discipline, their areas of activity or the community to which they belong.

By aligning methods, harmonising procedures and comparing results, a common system of reference needs to be established at Union level. Given its institutional proximity to the development of the Union's policies and its independence of national and private interests, the JRC could, in line with its mission, play a significant role in the development of a European scientific and technical reference area. This would be built up on the basis of national reference centres, European agencies, the various scientific committees and the organisations established at European level, such as the Food Safety Authority, free of industrial and political interests and open to public enquiry and scientifically recognised, which the Commission has suggested be established by 2002 following broad consultation.

⁹ COM(99)719.

5. MORE ABUNDANT AND MORE MOBILE HUMAN RESOURCES

5.1. Greater mobility of researchers in Europe

Mobility is an effective and well-known way of training researchers and spreading knowledge. Activities undertaken by the Union to encourage this have met with great success. In recent years almost 8 000 young European scientists have taken advantage of this option and a further 13.000 are expected to do so over the next four years. To date this measure has been largely for training purposes.

Overall, researchers are more mobile than the rest of the population. Roughly speaking, their level of mobility is around 5% of the active population whereas 2% is the average for other professional groups. That said, they are still not as mobile as they could be in proportion to requirements.

One aspect which plays a significant role is the lack of familiarity of European researchers with the research "cultures" that exist in other countries, and the lack of attraction that they feel for them. There are also obstacles of an administrative nature. Application at national level of Community directives on free movement and right of establishment, social or pension cover, is not always straightforward and requires an effort from interested parties which can be dissuasive.

More use should be made in future, at national and European level, of the possibility of using mobility as an instrument of information and technology transfer.

The mobility of researchers between the academic world and the business world, in the different forms that this might take, should also be readily encouraged and developed. This is one of the best ways of improving cooperation between universities and industry.

Information, training and familiarisation projects for researchers and the administrative managers of research organisations should, moreover, be undertaken in tandem by the Member States and the Commission. In the longer term the possibility should be looked at of improving, on a co-ordinated basis, for the bodies concerned, certain internal regulatory and administrative provisions.

5.2. Introduction of a European dimension into scientific careers

In Europe today the career of researchers unfolds by and large within a national reference framework. Recruitment methods that give preference to nationals for academic or scientific careers and the lack of adequate career structures for researchers from other European countries deprive research organisations of the possibility of benefiting from the experience and knowledge of brilliant researchers trained elsewhere. Appointments and promotions amounting in some cases to penalising researchers that have remained outside national frontiers for too long discourage mobility.

Initiatives have been taken in some Member States to introduce a European dimension into careers, such as opening up researcher recruitment committees to scientists from other countries. This trend and the adoption by research bodies of measures along these lines should be encouraged, as should the establishment of career prospects for researchers from other European countries and the systematic inclusion of activities performed elsewhere in Europe or at European level in career assessments.

5.3. Greater place and role for women in research

There are not enough women in research in Europe. Although they account for 50% of university graduates and even exceed the number of men in some subjects (life sciences and technologies, for example), they are not found in the same proportions in the laboratories and research departments of companies. Their progress in a scientific career is slower than that of men and their numbers start to rarefy as we climb the ladder of responsibilities. At the top of the academic hierarchy in the European Union, for example, there are on average fewer than 10% women.

There are several factors behind this situation, in particular certain discrimination mechanisms and anticipation of them by women and little attention paid to particular constraints facing women in the conduct of their professional lives. This is a loss for women themselves, for research and for society.

Measures have been taken in all the Member States to rectify this situation. The European Union has taken a major initiative in this area. In February 1999, the Commission presented a communication entitled "Women and science"¹⁰ which was the subject of a favourable resolution from the Council. It is accompanied by a plan of action which is now being put into effect.

This effort should be continued and developed and the aim of increasing the number of women in research will be achieved that much more easily if it is pursued jointly at national and at the Union level.

5.4. Giving the young a taste for research and careers in science

More human resources for research in Europe also means action upstream of scientific careers. Every country in the Union is observing a disaffection for scientific study and a loss of interest among the young in careers in research. In Germany, for example, the number of physics students has dropped by half since 1991. In the United Kingdom the number of future teachers of physics slumped from 553 in 1993 to 181 in 1998. And in France the number of science students dropped from 150 000 in 1995 to 126 000 in 1999.

A key question revolves around science teaching. It is at school that a basic knowledge and understanding of science is acquired and that a taste for scientific and technical subjects is developed.

In the continuation of often long traditions in science teaching and learning, initiatives have been taken in the Member States to make the public and in particular the young more familiar with science and its methods. Accordingly, the Commission organises a competition each year for young European scientists.

The Member States and the Union should rapidly undertake a joint in-depth study of the room made for science subjects in education systems and how the teaching of sciences in Union can be improved at levels of education, primary, secondary and further.

Using the experience gained at national level, awareness-raising campaigns should also be stepped up to create conditions conducive to the sharing of experience and good practice. The Research Ministers of the Union met to explore the possibility of better coordination of

¹⁰ COM (99)76.

the different "science weeks" organised in the Member States, both between one another and with the Union's "European Science and Technology Week". Organisation at the same time of events in all the Member States and on a European scale would markedly increase the awareness-raising effect.

6. A DYNAMIC EUROPEAN LANDSCAPE, OPEN AND ATTRACTIVE TO RESEARCHERS AND INVESTMENT

6.1. A reinforced role for the regions in the European research effort

Europe's scientific and technological fabric lacks cohesion. Although they are being narrowed down, the development gaps between European regions in terms of the production of scientific knowledge and technological innovation are still appreciable. In an attempt to reduce these gaps the Structural Funds set aside EUR 12 billion for research and technological development projects between 1989 and 1999: development of research facilities; creation of science and technology parks; science and technology training activities; in certain cases, research as such.

In most of the Member States the regions are also tending to play an increasingly positive role in research and innovation, benefiting from sometimes significant resources and launching initiatives to promote the development of links between universities, companies and research centres locally.

The opportunity should be taken to negotiate on the structural assistance planned for the years 2000 to 2006 in order to examine how best to combine projects implemented within this framework with projects undertaken in the European programmes.

Going further, the conditions must be studied and put in place for a real "territorialisation" of research policies (adaptation to the geographical socio-economic context), and a better understanding and strengthening is needed of the role that the regions can play, in addition to the Member States and the Union, in the establishment of a more dynamic European research area on the international scene. To this end, activities and measures undertaken to encourage research first have to be benchmarked. It would also be useful to establish a balance of the best ways of transferring knowledge to the economic sector at regional and local level.

The Member States and the Commission should also make a joint analysis of how best to use the "prime regional movers" to develop a more dynamic scientific and technological landscape in Europe, in particular by developing the role of training in science and technology that the centres of excellence can and should play.

6.2. Integration of the scientific communities of western and eastern Europe

Improving the research capacities of the countries applying for accession and integrating their researchers in the European scientific community can help them to prepare for accession.

Scientific and technological cooperation projects undertaken in recent years with these countries by the Union and by the Member States have made a first contribution along these lines. Association of applicant countries in the fifth framework programme for research opens up the possibility for their organisations to participate in European programmes under exactly the same conditions as the countries of the Union.

The challenge of enlargement of the Union in the field of research is proportional to its potential contribution to the creation of the European research area. Applicant countries currently spend less on research and their research structures have to be adapted to the need to apply knowledge for economic and social purposes. Applicant countries from central and eastern Europe can take advantage of funds from the PHARE programme for assistance to finance part of their contribution to the fifth framework programme (for which they benefit from a diminishing reduction).

These funds and the contributions made from the research programmes should be used in tandem. One aim should be to strengthen the research capacities as well as research administration capacities in applicant countries. The expertise available in national and European research administrations and organisations should be mobilised to this effect.

6.3. Making Europe attractive to researchers from the rest of the world

Research institutes do not have the same magnetic attraction on researchers from all over the world that American laboratories, companies and universities do. Europe does not offer researchers from third countries particularly advantageous (material and administrative) conditions.

The formalities to be completed are generally unwieldy. The regulations and languages also vary from one country to another. And the "brain drain", which some have claimed is being held in check, has not stopped. Between 1988 and 1995, 8 760 Europeans students took a doctorate in the United States. Five years after obtaining their diplomas about half of them were still in the United States.

To attract the best researchers from all over the world to European laboratories a European system of grants for scientists from third countries might be set up. National and European research programmes could also be more open to researchers and teams from countries outside the Union.

In the case of developing countries, to guarantee the development of local research potential, this system should be such as to encourage the beneficiaries to return to their countries in order to take advantage of their experience and to spread the knowledge they have acquired.

Measures should be taken at national and European level to encourage the return to European laboratories of researchers who have left to complete their training or pursue their careers in the United States.

The possibilities provided by the science and technology cooperation agreements between the Union and a number of third countries should be maximised in these respects.

Finally, it is especially necessary to improve appreciably the environment provided for researchers in Europe. An effort should be made in particular to simplify and harmonise regulations and administrative conditions more. Rules have recently been adopted in France, for example, to shorten the procedures for granting visas to researchers from third countries.

7. AN AREA OF SHARED VALUES

7.1. Tackling the questions of science and society in their European dimension

Europeans are attached to a model of society based on a combination of a market economy, a high level of social protection and quality of life and a number of principles, such as free access to knowledge. They are also aware of the richness of their cultural diversity and sensitive to the need to preserve it.

European countries are increasingly faced with common or identical problems, which they are tending to tackle at Union level. It is thus increasingly at European level that “science/society” questions arise, such as technology/work relations or the principal options in terms of energy, environment and health.

These matters need to be approached at this level in the dual interest of common values and European diversity.

More consistency should be introduced into foresight exercises, science and technology watch, socio-economic intelligence and scientific and technological options taken at national and European level and within the framework of the numerous existing networks. There is a need to establish a platform for exchange, to create points of synthesis and to align methodologies. The collection of data throughout the Union also needs to be improved and statistics and indicators developed at European level.

The development of new and sustained forms of dialogue between researchers and other social operators should also be encouraged.

On the initiative of the national parliaments, in particular, measures designed to open a direct dialogue between citizens, researchers, experts, industrial managers and political decision-makers have been initiated in recent years. Called “consensus conference” in Scandinavian countries and the United Kingdom or “citizens’ conference” in France, these formulas have illustrated the capacity of ordinary citizens to express valid opinions on complex issues and the possibility for groups with divergent interest to reach a consensus.

Exchanges of experience that have taken place in this arena should be encouraged and become systematic. Cross-participation formulas could also be tried. Conferences of this kind might also be organised at European level on issues emerging at that level.

7.2. Development of a shared vision of the ethical issues of science and technology

Cloning, embryonic tissues used for medical purposes, personal databases and virtual universes: progress in knowledge and technology, especially in fields such as life sciences and technologies and information technology, goes hand in hand with a growing number of ethical issues.

Europeans share largely the same values and adhere to the same fundamental principles. But they often differ in how to apply the latter in practice. Ethical issues concerning scientific and technological advance are thus approached differently from one country to another.

The differences in culture and moral sensitivity at the root of this variability have to be respected. That said, it would be hard to accept too great a difference. It is therefore important to foster convergent and coherent approaches to these issues, especially in areas where the Union is active.

The links between the ethics committees established at national and European levels (“European Group on Ethics in Science and New Technologies”) should be strengthened. To help make for mutual understanding of points of view and the development of harmonious approaches there should be encouragement to open up the various national committees to experts from other European countries.

The rules in force and the criteria on ethics used in national and European research programmes should be compared with a view to alignment around shared principles and respect for differences in sensitivities and opinions.

CONDITIONS FOR ACTION

1. LINES AND MEANS OF ACTION

The European research area will not come into being instantly in its final form. It will develop gradually. Of the measures suggested and others that might be, a distinction must be made between measures to be taken in the short, medium and long term, the former often being a pre-condition for the success of the other two.

Certain measures could be implemented immediately while others will need more time, e.g. measures requiring amendments to laws, regulations or administrative provisions at national or at European level.

An important aspect is the question of role-sharing. These roles and their attendant responsibilities should be defined in the light of the “principle of subsidiarity” in its broadest sense: measures must be taken at the level where they will be most effective. An efficient European research area thus means that the respective roles of the public and the private sectors need to be settled, along with what measures are to be taken at regional, national, European and international level. In the context of a global economy and in the light of problems emerging at planetary level, research activities sometimes have to be defined on a broader scale than European.

Very often the objective will only be achieved through a combination of initiatives, means and instruments at the different levels. In this respect the Union could play a leading role. It can provide a framework and an environment and help, for example, to accentuate and amplify the initiatives taken independently by the Member States to open up Europe as part of bilateral cooperation or multilateral initiatives.

The full panoply of instruments available to the Union should be brought into play:

- Practical instruments, such as databases and information systems;
- Structures and mechanisms of exchange of information and experience: working groups, networks of experts and operators;
- Financial instruments;
- Legal instruments: regulations and directives;
- Policy coordination instruments, making for a genuine political debate and culminating in recommendations or resolutions from the Council.

The range of possibilities provided by the Treaty (joint ventures, supplementary programmes, participation in national programmes, in particular) should be re-examined.

An important dimension is the comparison of situations and efforts. Benchmarking exercises could be undertaken, including the drafting of national reports. Using the results of these reports as a basis (which will require a joint effort by the Member States and the Union on the statistics front), as well as the European report on scientific and technological indicators and the work of Eurostat and the OECD, the Commission could draw up a periodic progress

report on research in Europe. Taking the form of a political analysis, this would provide an overall profile of the situation in Europe in this area.

This benchmarking should focus on the most pertinent aspects in order to review the impact of research on the development of a knowledge-based society and on employment. It should cover, in particular, public and private expenditure on research and technological development, the performance of systems of innovation and dissemination of results and the situation concerning patents. Special attention should be paid to the specific areas of this communication, e.g. mobility of researchers, measures taken to stimulate private investment (in tax matters, in particular), situation regarding risk capital, opening-up of national programmes, networking of centres of excellence, involvement of women in research, improvements to the unfolding of careers in science.

The approach taken in the employment sector can serve as a model. This is based essentially on the establishment of guidelines geared to the achievement of concrete objectives, the development of national plans of action and the presentation of joint reports on the implementation of those plans. Applying it to the field of research would have the effect of improving the consistency and providing greater convergence of policies undertaken at national and European levels.

The financial instrument for implementing the Union's research policy is still the framework programme. And it will have its part to play. The results of the important evaluation exercises five years into the framework programme and the specific programmes will be available in the middle of the year. These will be used as a basis for the preparation of the Sixth Framework Programme and for the first discussions on this subject.

In form as in content the Sixth Framework Programme will have to be thoroughly rethought out in the light of the project to develop the European research area. An extra effort must be made on issues that need to be tackled at European level. The methods of operating and assistance with the framework programme will also have to be re-examined and new means of action based on greater decentralisation of programme implementation need to be introduced after being studied and tested.

2. NEED FOR A BROAD-BASED DEBATE

Before any actual decisions are taken a broad-based debate has to take place. The analyses set out in this communication and the proposals put forward have to be discussed in depth.

This debate should unfold first and foremost in the European institutions: in the Council and in the European Parliament in extensions of discussions on the future of research in Europe that have been held in recent years and also in the Economic and Social Committee and the Committee of the Regions.

It is also essential to hear the views of the scientific community, the world of industry and, more broadly, "civil society".

The Commission will seek the views of the representative organisations established at European level. It will also invite the Member States to examine the possibility of organising debates at national and regional level along these lines and is willing to help organise them.

Research has more and more of an impact on everyday life. This debate must therefore be extended to all of European society. This will be done in particular by way of an electronic

forum. This Communication will be placed on the Internet and comments invited. Except where explicit requests for confidentiality are made, these comments will be made public through the same medium.

3. THE NEXT STAGES

The situation is urgent. Without a co-ordinated impulse and a determined effort to increase and better organise the European research effort, Europe might compromise its chances of taking full advantage of the potential offered by the transition to a knowledge-based economy and society. This will not be without its negative impact on growth and employment.

The European research area should be an area where the scientific capacity and material resources in Member States can be put to best use, where national and European policies can be implemented more coherently, and where people and knowledge can circulate more freely; an area attractive both to European researchers and to the best researchers from third countries and built on respect for the common social and ethical values of Europeans and their diversity.

The next stages along this path might be:

- An examination and discussion of this Communication by the European Parliament.
- A first informal debate at Research Ministers level under the Portuguese Presidency in March 2000.
- A contribution from the Commission on this subject at the European Summit on Employment in Lisbon in March 2000.
- A public debate in the Member States during the first six months of the year 2000.
- A second debate by the Research Council in June, when the Commission would ask the Council to give its assent to the opening of a number of areas of work on each of the themes identified in the communication.

ANNEX I

POSSIBLE SPECIFIC THEMES FOR ACTION

1. A SERIES OF MATERIAL RESOURCES AND FACILITIES OPTIMISED AT EUROPEAN LEVEL

1.1. Networking of centres of excellence and creation of virtual centres

- Mapping of European centres of excellence
- Creation of "virtual centres of excellence"
- Financing plan for centres of excellence on the basis of competition

1.2. Definition of a European approach to research facilities

- Analysis of the responsibilities as regards creation, operation and access
- Assessment of needs to be met at European level
- Establishment of a framework for discussion

1.3. Maximising the potential offered by electronic networks

- Promotion of the use of electronic networks in the various fields of research
- Awareness-raising and training campaigns for researchers

2. MORE CONSISTENT USE OF PUBLIC INSTRUMENTS AND RESOURCES

2.1. More co-ordinated implementation of national and European research programmes

- Application of the principle of mutual opening of national programmes
- Establishment of information mechanisms on the objectives and content of programmes
- Support for initiatives to evaluate national activities by international panels

2.2. Closer relations between European organisations for science and technology cooperation

- Establishment of a Council of senior officials from these organisations for policy consultation

3. MORE DYNAMIC PRIVATE INVESTMENT

3.1. Better use of instruments of indirect support for research

- Development of information systems on existing media
- Encouragement of the exchange and spread of good practices

3.2. Development of effective tools for the protection of intellectual property

- Support for the creation of the Community patent
- Greater consistency of the systems used in public research programmes
- Establishment of systems of information and exchange on good practices

3.3. Encouragement of risk capital investment and company start-ups

- Encouragement for national centres of research to provide technical support for start-up companies
- Initiatives for putting scientists, industrialists and financiers into contact with one another, in connection with national and European programmes

4. A COMMON SYSTEM OF SCIENTIFIC AND TECHNICAL REFERENCE FOR POLICY IMPLEMENTATION

4.1. Development of the research needed for political decision-making

- Alignment of research undertaken by the Commission on the concerns of citizens and decision-makers
- Establishment of a reliable and recognised system of validation of knowledge and control methods
- Networking of centres of excellence in the fields concerned

4.2. Establishment of a common system of scientific and technical references

- Establishment of a common system of reference at Union level
- Development of a European scientific and technical reference area based on the JRC, the national reference centres, scientific committees and establishments at European level

5. MORE ABUNDANT AND MOBILE HUMAN RESOURCES

5.1. Greater mobility of researchers in Europe

- Encouraging mobility as an instrument of knowledge and technology transfer
- Greater mobility of researchers between the academic world and business

- Training programmes for researchers and administrators
- Improvement of certain regulatory provisions

5.2. Introduction of a European dimension into scientific careers

- Encouragement for recruitment committees to open up to Europe
- Establishment of career prospects for researchers from other European countries
- Taking into account of activities undertaken elsewhere in Europe or at European level

5.3. Greater place and role for women in research

- Implementation of the "Women and science" action plan

5.4. Giving young people a taste for research and careers in science

- Better teaching of science at all levels in the Union
- Support for exchanges of experience and good practice in campaigns to raise young people's awareness of science
- Coordination of the "Science Weeks" organised in the Union

6. A DYNAMIC EUROPEAN LANDSCAPE, OPEN AND ATTRACTIVE TO RESEARCHERS AND INVESTMENT

6.1. Greater role of the regions in the European research effort

- Combined use of the Structural Funds and the European research programmes
- Benchmarking of the research activities of the regions and measures taken to encourage research
- Balance of the best ways of transferring knowledge to the economic sector at regional level
- Analysis of the role of the “prime regional movers” in the development of more dynamic a European scientific area

6.2. Integration of the scientific communities of Western and Eastern Europe

- Mobilisation of expertise available in the Union to increase the capacities of research and research administration in applicant countries

6.3. Making Europe attractive to researchers from the rest of the world

- Creation of a system of grants for scientists from third countries
- Opening of national and European research programmes to researchers from third countries

- Simplification and harmonisation of regulations and administrative conditions
- Encouragement for researchers that have left for the United States to return to Europe

7. AREA OF SHARED VALUES

7.1. Tackling science/society issues on a European scale

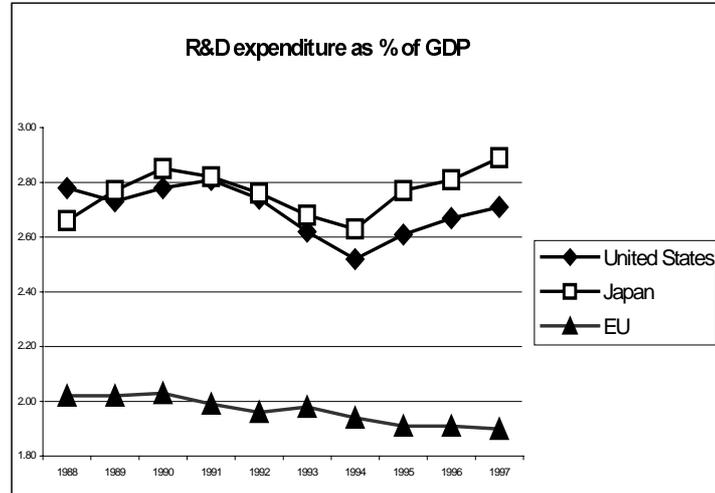
- Greater coherence of foresight exercises and socio-economic intelligence at national and European levels
- Establishment of a platform for exchange
- Development of statistical indicators and harmonisation of data and methodologies on a European scale
- Organisation of “Citizens’ Conferences” at European level

7.2. Development of a shared vision of ethical issues in science and of technology

- Strengthening of links between national and European ethics committees
- Opening-up of national ethics committees to experts from other European countries
- Comparison of criteria used in the national and European programmes with the prospect of convergence around common principles, while respecting diversity

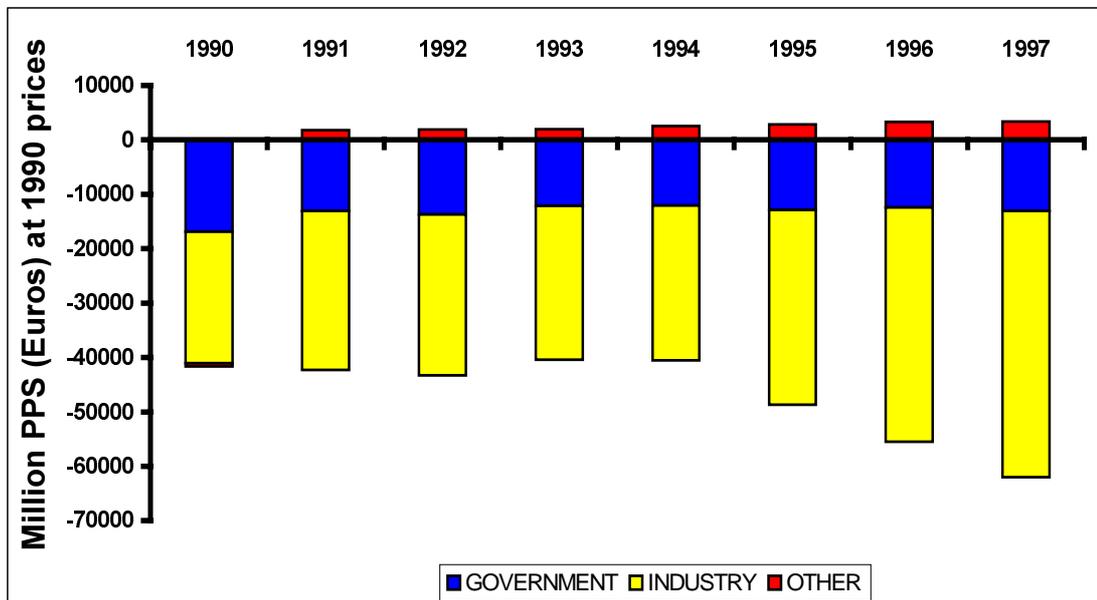
ANNEX II

1. **THE UNION'S OVERALL RESEARCH EFFORT IN RELATION TO ITS GROSS DOMESTIC PRODUCT HAS BEEN STEADILY DECLINING FOR 10 YEARS. THE GAP IS WIDENING IN RELATION TO THE UNITED STATES AND JAPAN**



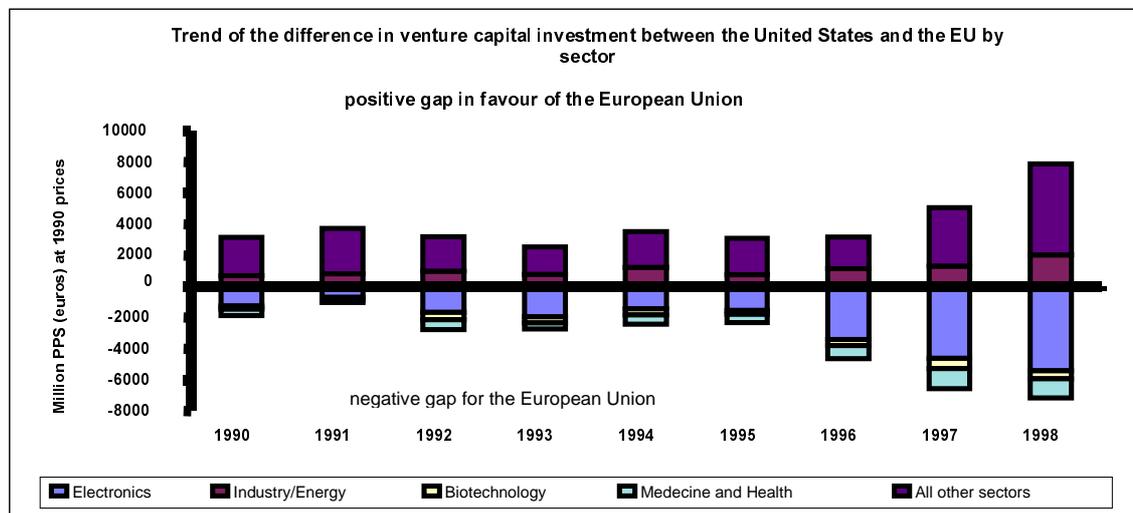
Source: Eurostat

2. **THE GAP BETWEEN R&D EXPENDITURE IN AMERICAN AND EUROPEAN FIRMS IS MUCH WIDER THAN THE DIFFERENCE IN PUBLIC SPENDING**



Source: Research DG, based on OECD data

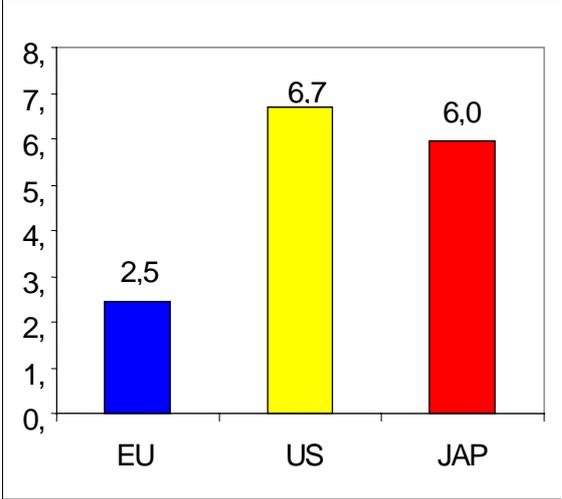
3. THE UNITED STATES INVESTS MORE VENTURE CAPITAL THAN THE EUROPEAN UNION IN HIGH TECHNOLOGY AND IN FUNDING INNOVATIVE START-UPS



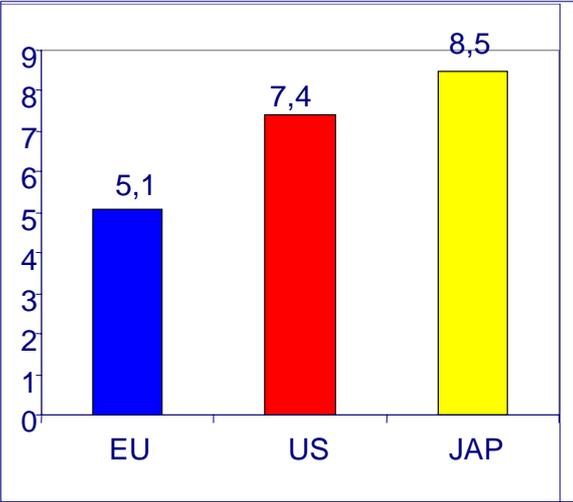
Source: Research DG, based on EVCA and NVCA data

4. THE EUROPEAN UNION HAS FEW RESEARCHERS IN COMPARISON WITH THE UNITED STATES AND JAPAN AND EUROPEAN FIRMS EMPLOY MANY FEWER RESEARCHERS THAN THEIR AMERICAN AND JAPANESE COUNTERPARTS

Number of researchers in firms per 1 000 labour force, 1997



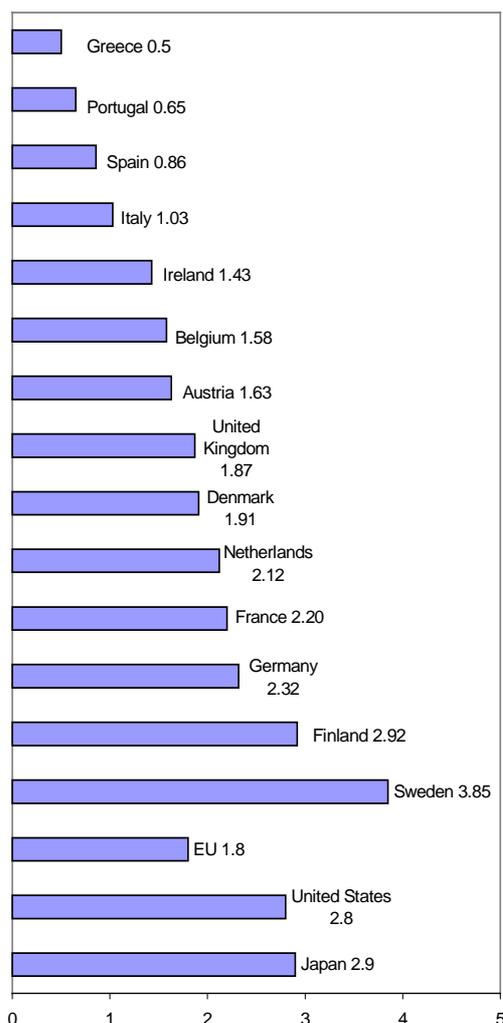
Number of researchers per 1 000 labour force, 1997, or most recent year



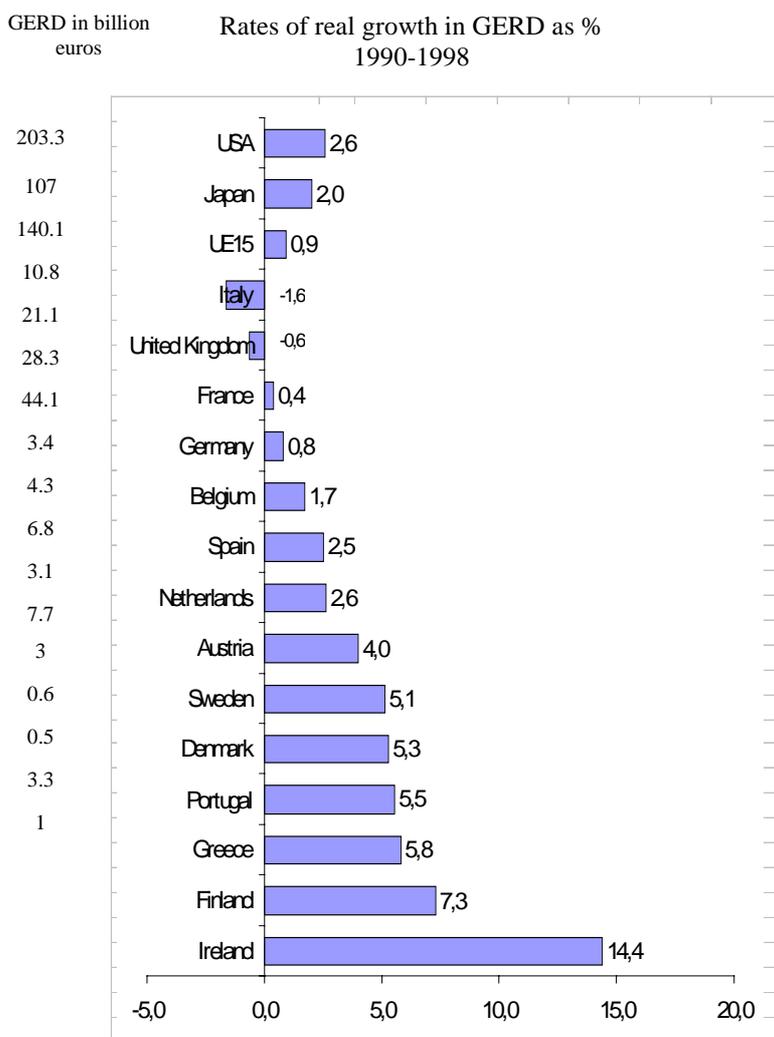
Source: Research DG, based on OECD data

5. LEVELS OF R&D INVESTMENT IN THE MEMBER STATES STILL VARY WIDELY, BOTH AS A % OF GDP AND IN ABSOLUTE FIGURES. IN RECENT YEARS COUNTRIES WITH THE LOWEST INVESTMENT HAVE STEPPED UP THEIR EFFORTS IN PARTICULAR.

**Intensity of R&D (GERD/GDP)
for the EU, United States and Japan -
1998 or most recent year**



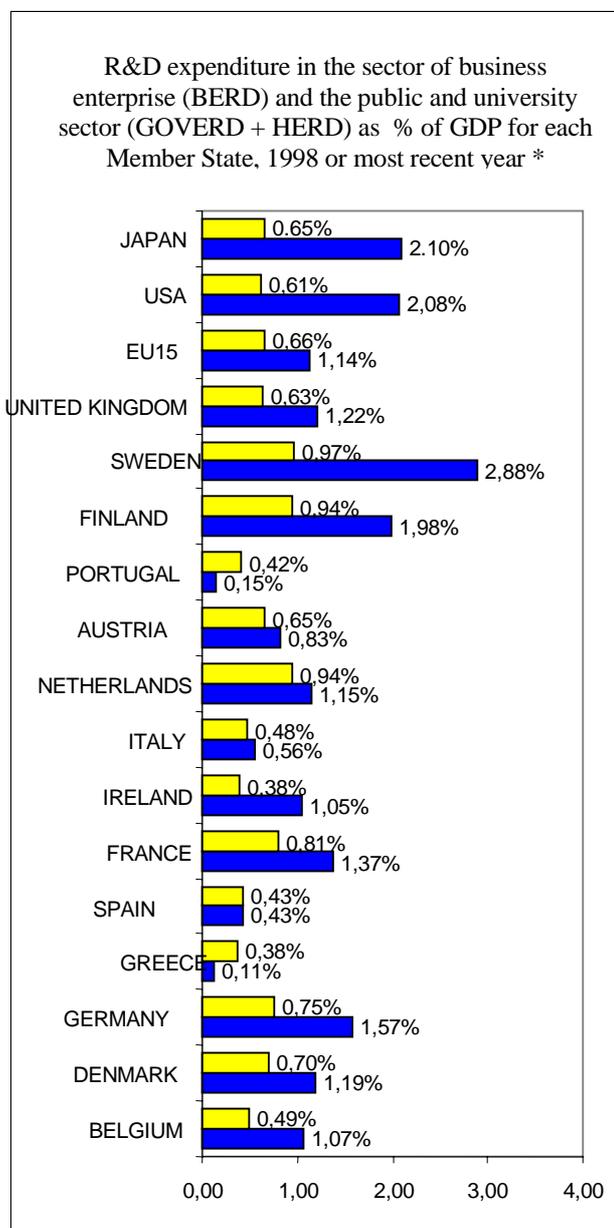
**Total R&D expenditure in the Member States between
1990 and 1998**



* The rates of real growth in GERD for each country are calculated in purchasing power standards (PPS) at constant prices for 1990. The real growth for Japan refers to the period 1997/1990. GERD refers to 1996 for Belgium and 1997 for Greece, Ireland, the Netherlands, Portugal, Sweden, the United Kingdom and Japan.

Source: Research DG, based on OECD and Eurostat data

6. THE BREAKDOWN OF RESEARCH EXPENDITURE BETWEEN THE PUBLIC SECTOR (GOVERNMENT RESEARCH ORGANISATIONS AND UNIVERSITIES) AND THE PRIVATE SECTOR VARIES CONSIDERABLY IN THE EUROPEAN COUNTRIES.



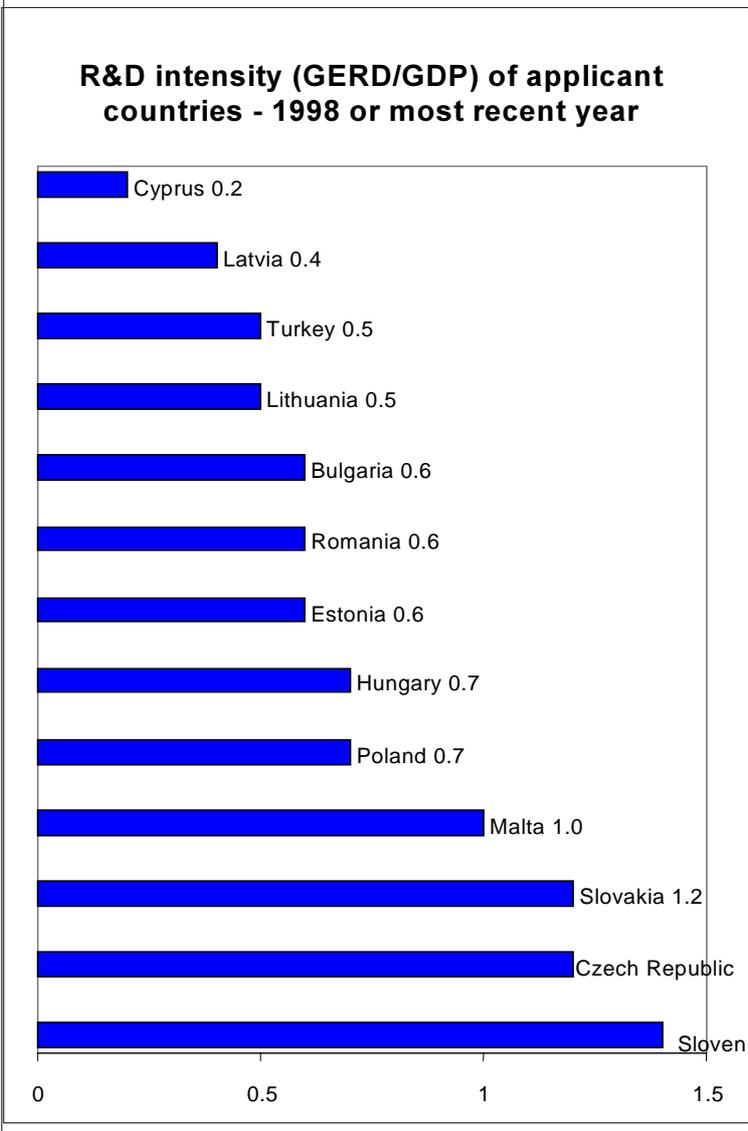
■ BERD//GPD

■ GOVERD+HERD/GPD

* Any slight differences in the sum of the percentages for a given country over the global percentages shown in Table 5 (left) are due to the non-consideration of other (limited) categories of expenditure (private sector for non-profit-making purposes) and/or differences in the last year of available data.

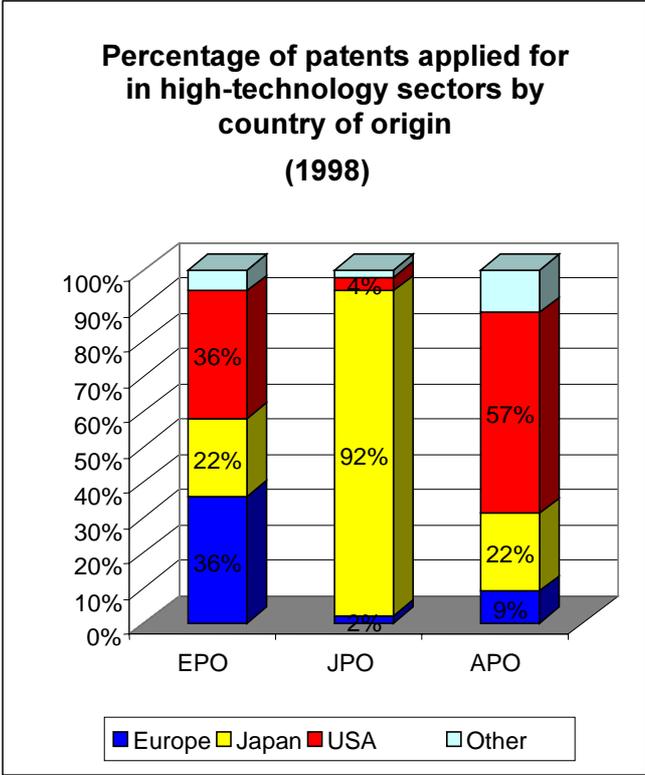
Source: Research DG, based on OCDE data, 1999

7. INTENSITY OF R&D IN APPLICANT COUNTRIES IS SUBSTANTIALLY LOWER THAN THE EU-15 AVERAGE.



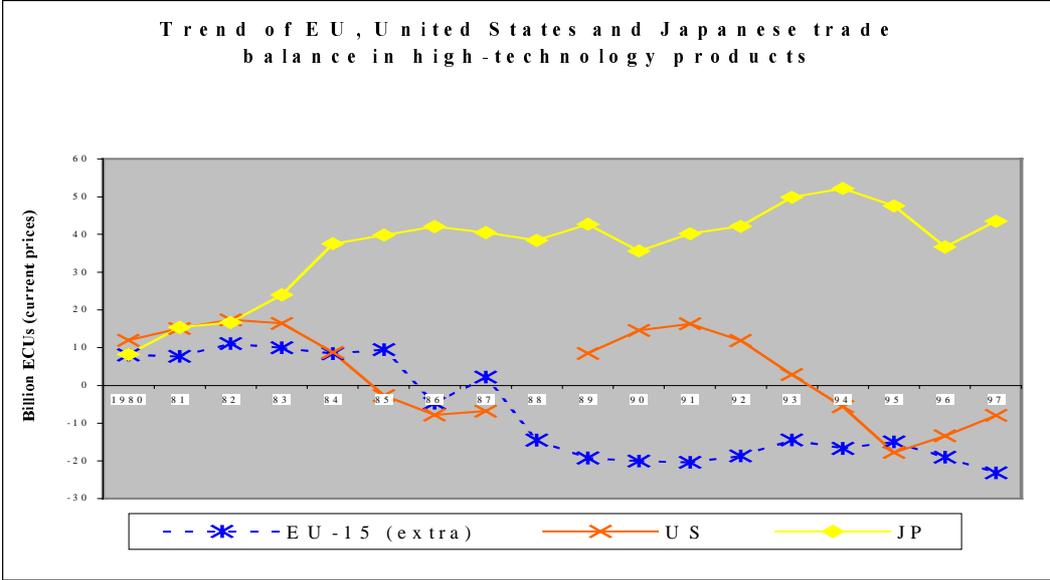
Source: OCDE and Eurostat, except for Malta (Malta Council for Science and Technology)

8. IN HIGH-TECHNOLOGY SECTORS, EUROPEAN COUNTRIES ACCOUNT FOR ONLY 36% OF PATENTS APPLIED FOR IN EUROPE, AND ONLY 9% AND 3% OF PATENTS APPLIED FOR IN THE UNITED STATES AND JAPAN RESPECTIVELY. ON THE OTHER HAND, THE UNITED STATES AND JAPAN ACCOUNT FOR 36% AND 22% RESPECTIVELY OF APPLICATIONS TO THE EPO FOR PATENTS IN THOSE SECTORS.



Source: European Patent Office (EPO), Japanese Patent Office (JPO), US Patent and Trademark Office (USPTO) - Trilateral Statistical Report (1998)

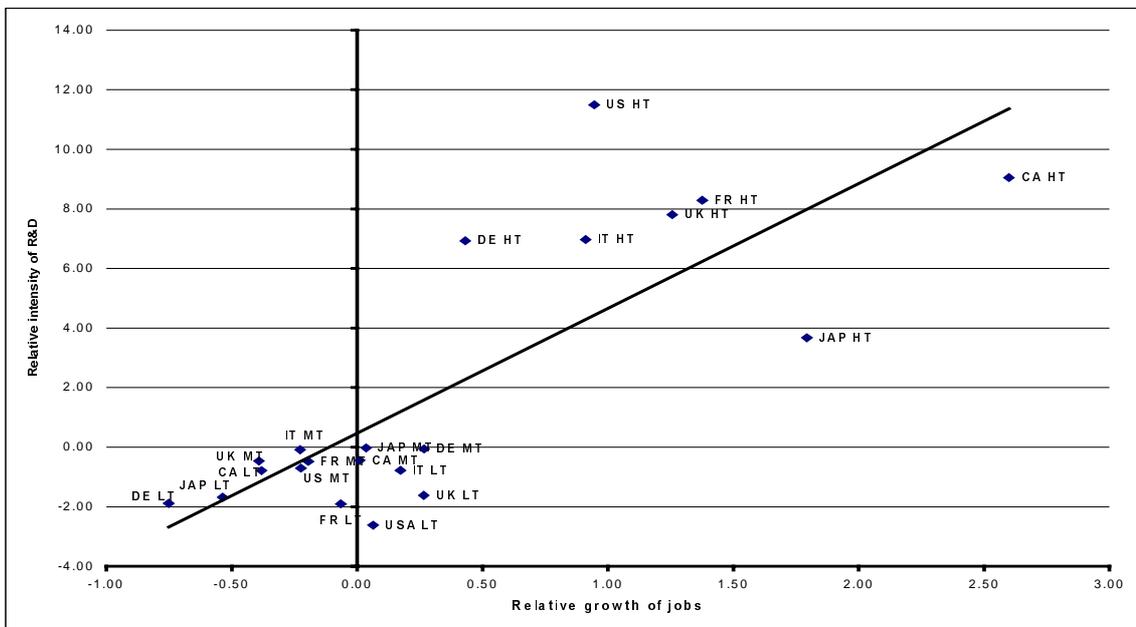
9. THE EUROPEAN UNION DEFICIT OF FOREIGN TRADE IN HIGH-TECHNOLOGY PRODUCTS HAS BEEN WORSENING SINCE 1987



Source: Research DG, Eurostat, Key Figures in S&T, 1999

10. HIGH-TECHNOLOGY INDUSTRIES CREATE MORE JOBS THAN OTHERS. COUNTRIES SPECIALISING STRONGLY IN HIGH-TECHNOLOGY SECTORS ARE BETTER AT COMBATING UNEMPLOYMENT

Intensity of R&D and growth of jobs - high-tech (HT) medium-tech (MT) and



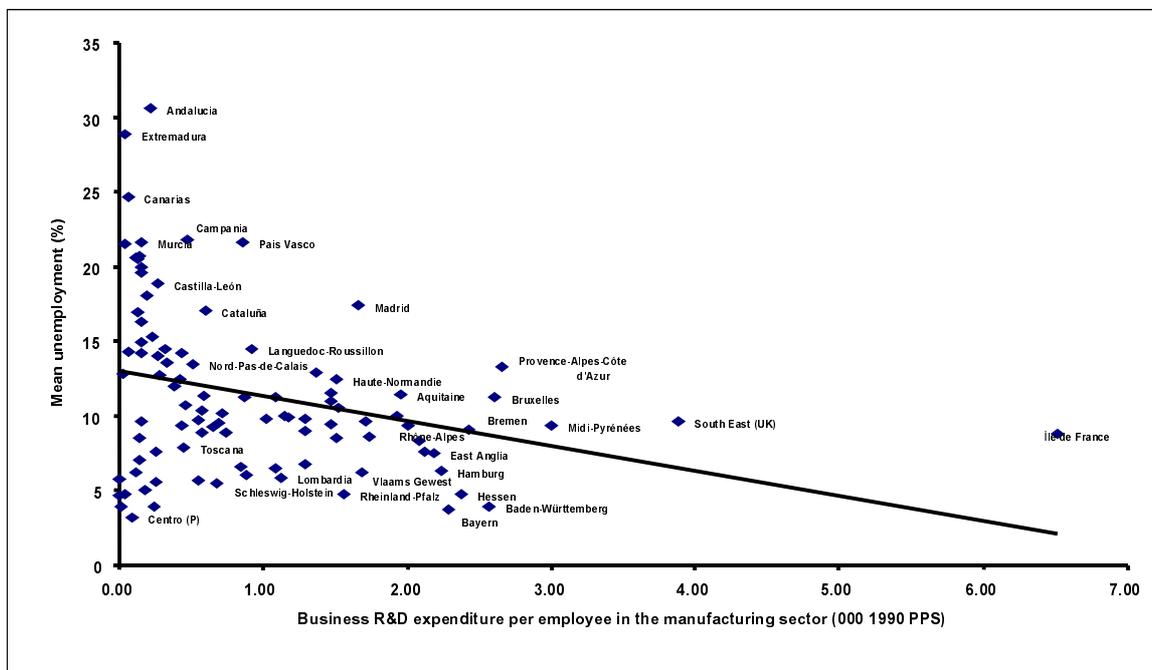
low-tech (LT) industries in the G7 countries (1977-96)

Source: Research DG, based on OECD data

11. INDUSTRIAL R&D EXPENDITURE AND UNEMPLOYMENT BY REGION (1992-95)

European regions investing more in R&D have relatively lower levels of unemployment

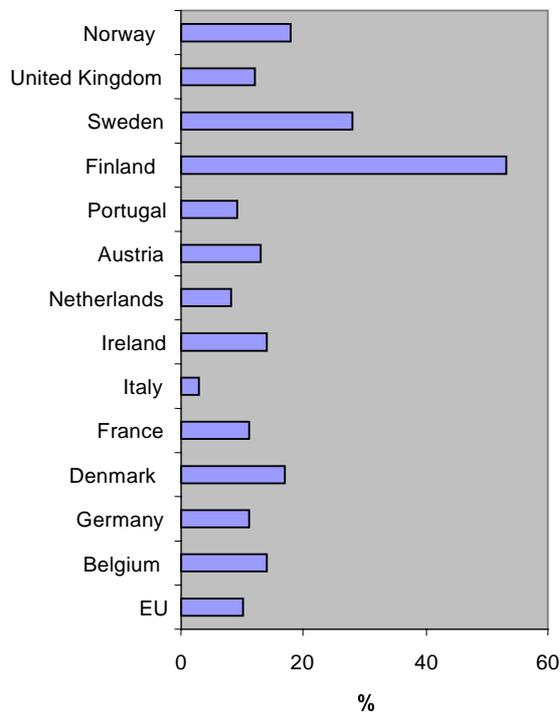
Source: Research DG, based on Eurostat data



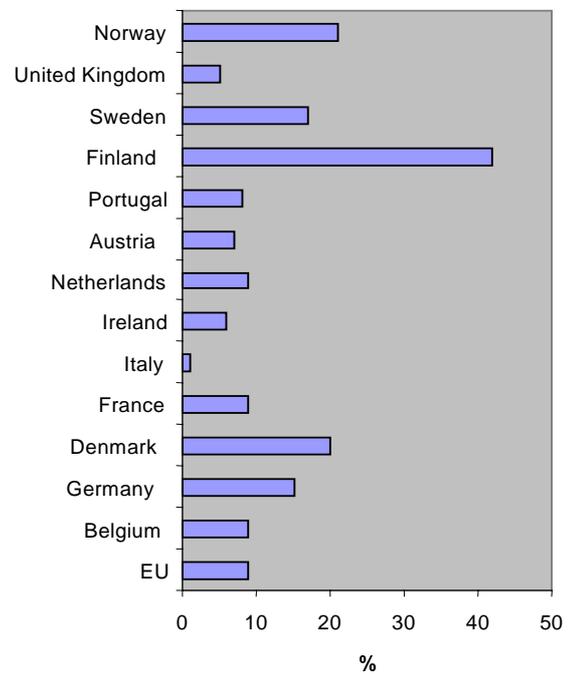
12. COOPERATION AGREEMENTS BETWEEN FIRMS AND UNIVERSITY OR GOVERNMENT RESEARCH INSTITUTES ARE NOT VERY WELL DEVELOPED IN MOST MEMBER STATES OF THE UNION. ON AVERAGE, A LITTLE OVER 10% OF FIRMS COOPERATION WITH RESEARCH INSTITUTES.

Cooperation between firms and universities and research institutes

Proportion of innovative firms having cooperation agreements with universities (1994-96)



Proportion of innovative firms having cooperation agreements with government research institutes (1994-96)



Source: Eurostat, Enterprise DG, 2nd Community Innovation Survey