LEAGUE OF EUROPEAN RESEARCH UNIVERSITIES

RESEARCH-INTENSIVE UNIVERSITIES AS ENGINES FOR THE "EUROPE OF KNOWLEDGE"

SUMMARY

- *European basic research has decayed in recent years and must be reinvigorated if a "Europe of Knowledge" is to be realised.*
- *Successful exploitation of research-based innovation is increasingly at the heart of much change within society and crucial to its economic success.*
- *The example of the USA suggests that such success depends upon highly creative basic research and a profound capacity to exploit it commercially and societally. That success is based on:*
  - *strong investment in basic research infrastructure and strong project funding;*
  - *strong support for the careers of young researchers;*
  - *a research culture in private industry, commerce and the public service.*
- *The European research effort is significantly less successful than that of the USA, and its economy less research intensive and less innovative.*
- *Europe needs:*
  - *a world leading research base;*
  - *industry with the capacity to exploit research as part of its competitive armoury;*
  - *effective mechanisms for interaction between them.*
- *In research, it is imperative that the European effort in basic research is strengthened by exploiting the unique capabilities of research-intensive universities, that have proved so successful in the USA and that are being emulated through government policy in many developing countries. Europe must:*
  - *increase funding to improve research infrastructure and project funding;*
  - *help research-intensive universities to develop greater financial flexibility;*
  - *ensure that funding is competitive;*
  - *develop a cohort of excellent and ambitious young researchers and ensure that they are placed in intellectually challenging and well supported centres.*
- *The research intensive capacity of industry, able efficiently to exploit the research base, must be strengthened together with tripartite collaboration between universities, industry and government.*

RESEARCH AND UNIVERSITIES IN MODERN EUROPE

1.1 The capacity of a society to create and introduce beneficial innovation is vital to its economic success and its social and cultural vitality. Most of this innovative capacity is derived from research, and since the middle of the 19th century, most research has been done within universities.

1.2 There is a vital distinction between basic research on the one hand and strategic and applied research on the other (Box 1). Basic research is concerned with the ultimate explanation of phenomena. It is sometimes referred to as "blue skies research", and there is often little apparent relationship between the motives for doing it and the implications of its findings. Its uncertainties make it unappealing to many who control public funds for research, compared with strategic and

LERU OFFICE - PARIJSSTRAAT 72B/03.27 - B-3000 LEUVEN - BELGIUM
TEL +32 16 32 99 69 - FAX +32 16 32 99 68
WWW.LERU.ORG - INFO@LERU.ORG

applied research which focus on well defined aims that can be readily justified by social or economic need. However, it has a powerful potential to re-define our knowledge, create new explanations, new possibilities and new questions. It can have an immense impact on technology and society and re-defines priorities for strategic and applied research. It is also a powerful training ground for developing the creativity of researchers whose skills may then be directed towards strategic and applied goals. Basic research is thus vital to a healthy strategic and applied capability, but because of its uncertainties, it requires confidence and optimism amongst politicians and planners to ensure that this vital ingredient of the research effort is maintained. Sadly, the European effort in basic research has decayed in recent decades, and if the aspiration for a "Europe of Knowledge" is to be realized, basic research must be reinvigorated.

BOX 1 Routes to direct exploitation of research

There is a conventional distinction between *Basic, Strategic* and *Applied Research*, purporting to reflect its distance from application. *Basic research* seeks to acquire new knowledge about fundamental phenomena. *Strategic research* seeks to establish the basis of solutions to practical problems. *Applied research and development* draws on existing research to produce marketable new products, processes, systems or services. In practice, this suggested linear process is increasingly short-circuited, with many basic research innovations leading rapidly to practical application. The supposed dualism between basic research and strategic/applied research has meant, in periods of budgetary restraint, that an increase for one has led to a decrease in the other. This is increasingly a mistaken dualism, but one that has dictated the approach of the EU Framework programmes.

In many areas of life science, biomedicine, materials science, computer science and electronics, exploitation of novel technologies that create new market trajectories have tended to come from basic research in universities or research institutes. Innovative basic research with market potential is often absorbed by industry by acquisition of "spin-out" companies from the parent bodies. These trends are reflected in the increase in citations of basic research papers in applications for patents[1,2].

Much social policy in areas such as energy, the environment, health, genetic manipulation and in non technological areas, such as education, housing, the economy and governance depends directly upon advice given by university-based researchers in relevant fields of science and technology on the one hand and the social sciences, economics and philosophy on the other.

Recent years have seen burgeoning popular interest in the humanities, for example in the enthusiasm for history, reflected by its popularity in television and print media and in heritage sites and experiences. Although much is based on existing knowledge, mostly derived from university research, it has both inspired and benefited from new historical research, such that historical debates at the forefront of understanding are now matters of popular interest.

1.3 The great days of European research were in the 18th and the first half of the 20th century, when European universities had the resources and flexibility to fund their staff to pursue promising opportunities to create new knowledge, irrespective of its apparent relevance to contemporary economic or social priorities. Since then, governments have increasingly recognized the value of universities in satisfying a diversity of needs: as providers of trained personnel, as providers of credible credentials, as creators of useful knowledge in supporting economic development, in promoting mobility and social justice and in developing cultural engagement. These developments have had a profound impact on the nature of European universities and research. The funding of European universities has not kept pace with the demands made upon them. (For example, funding for tertiary education in most European countries is now little more than half that of the USA and Canada as a proportion of GDP – Box 2.) This has severely reduced universities' capacities to set and fund their own priorities for research. At the same time, external funding bodies, such as government research councils and the EU, have increasingly allocated funds for research through pre-defined strategic themes, often identified through "Foresight" processes, although the record

1. F.Narin, K.S.Hamilton, D.Olivastro. 1997. *Research Policy*, 26, 317.
2. J.Anderson, N.Williams, D.Seemungal, F.Narin. 1996. *Technol. Anal. Strat. Manag.*, 8, 135.

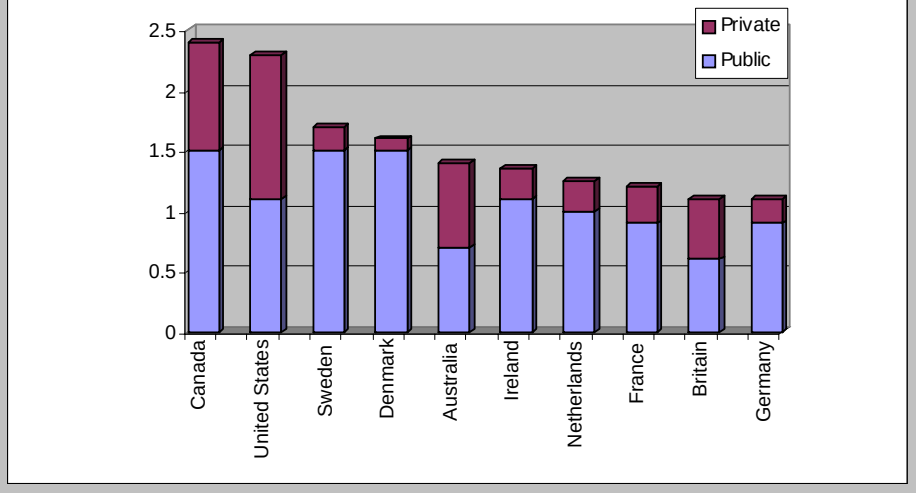
of past attempts at foresight is not impressive[3]. The consequence has been that universities have lost the capacity to set their own research agenda, and their research has become increasingly strategic, driven by the immediate needs of industry and government policy.

1.4 Whereas the strategic flexibility of universities and their autonomy to pursue their own research has diminished, government funded research institutes have been created with core funding for research that gives them the flexibility to plan and execute their own research. Universities have two major advantages over such institutes:

- leading edge research underpins the education of students and the next generation of researchers, both key outputs from the research process;
- universities undertake a uniquely broad range of research compared with either research institutes or industry, permitting them rapidly to reconfigure their research efforts to pursue new opportunities in an unrestricted way, whilst mission-led institutes can lose their *raison d'être*, to become a force for conservatism.

In Europe, the Framework Programmes contribute to the process of undermining university research power in favour of research institutes. It is a fundamental strategic error. It is not an error being made by Europe's competitors in North America or in other countries that are investing strongly in their research base.

BOX 2



BOX 3

"The non-hierarchical nature of most North American and northern European universities, coupled with the pervasive presence of irreverent young undergraduate and postgraduate students, could be the best environment for productive research. The peace and quiet to focus on a mission in a research institute, undistracted by teaching or other responsibilities, may be a questionable blessing." (R.M.May: The Scientific Wealth of Nations. *Science*, 1997, 793-796.)

3. The Roosevelt Commission of 1937, set up by the US President to advise on the most likely innovations of the succeeding 30 years not only identified many unrealised technologies, but missed nuclear energy, lasers, computers, xerox, jet engines, radar, sonar, antibiotics, pharmaceuticals, the genetic code and many more.

RESEARCH, ITS EXPLOITATION AND RESEARCH-INTENSIVE UNIVERSITIES – THE US EXAMPLE

2.1 Successful exploitation of research-based technological innovation is, increasingly, the driver of national economies and of much change within society. It is conventional to think of a long lead-time between basic research and its application (Box 1). This view is increasingly outmoded as the lead-time between basic research that creates new knowledge and its technological application is progressively shortening. Discovery and exploitation are not however the same. But where the two processes interact strongly, both benefit, and create a strongly innovative culture, in which the creation of new knowledge is highly regarded and supported and brings the greatest benefit to society and to the economy. The process is at its most dynamic, at least in the economic domain, in the USA, where those familiar with markets interact creatively with researchers, in a context in which those with investment capital are ready to support innovation.

2.2 An effective innovation system must have the capacity to exploit new ideas no matter what their origin. This is reflected in the US by the fact that not only do US companies dominate patenting in the USA, but also take out more European patents than do European companies. It is important not only to create new knowledge but also to understand the significance of new knowledge created elsewhere. This capacity, and the capacity to exploit the unexpected outcomes of much research, depend upon maintaining a broad capability in basic research, which continuously re-synthesises specific knowledge in the form of general understanding that is broadly applicable. Such generic understanding represents a fundamental "transferable skill" which can be applied to a much wider range of circumstances and phenomena than can a catalogue of specific knowledge. People trained through the discipline of basic research are as important a resource for society as are the concepts and technologies created by research.

2.3 The profound capacity of the United States for highly creative basic research and the profound complementary capacity to exploit it commercially rest on three pillars:

a) Strong investment in infrastructure and strong funding for basic research.
Much of this is located in universities or is accessible for university use, rather than in research institutes. It is however highly concentrated, with 66 % of federal funding (much the largest source of basic research funding) going to 25 research-intensive universities. The National Institute of Health, the largest research institute in the world, allocates only 11% of its $27.3 billion budget (2003) to intramural research, the rest is allocated on a competitive basis mainly to universities. US research intensive universities also tend to have large endowments that are a source of strategic flexibility, giving them the capacity to pursue new opportunities as they see fit.

b) Strong support for the careers of young researchers.
The prospect of postgraduate research is a positive one for young graduates, for two reasons:
- a doctoral degree is a valued qualification in US companies – 80% of US PhD graduates work in industry compared with only 50% in Europe;
- research careers are seen as exciting and stimulating, largely in our view because of the strong support for basic research, which permits young US researchers to take on the most demanding research challenges that are often beyond the resources available to even the most seasoned researchers elsewhere, and because of the climate of confidence based on past success which encourages them to do so.

c) A research culture in private industry, commerce and in public service.
There is a strong pull from industry on the research base. Industry actively seeks out basic research that it can translate into market relevance, enabled by its own investment in research and its employment of research-trained personnel. It does not seek to persuade universities to undertake strategic and applied research, that is its own role, but supports the dualism described in paragraph 2.1. As a consequence of the strong pull from industry, many

US universities that are regarded as engines of industrial innovation do not need to have a proactive policy to support economic development.

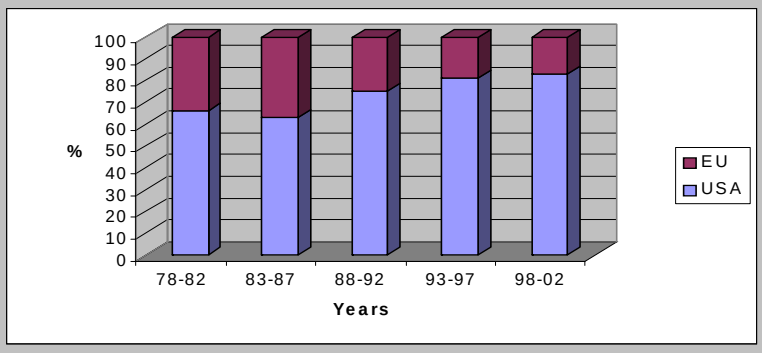
BOX 4 Interaction between the academic research base and industry "pull" in generating innovation in US regions[4]

- R&D employment in the industry of a particular region has a positive overall effect on the innovation output;
- a region's university-level research can only have a positive effect on the innovation output in that region if there is sufficient interaction between academic research and the high-tech/professional entrepreneurial environment;
- the presence of a flourishing "texture" of high-tech ventures/star-ups coupled with strength in a region's academic research base has a significant positive impact on the health of innovation in a region;
- however, an overly strong presence of large, established manufacturing-intensive firms, in interaction with a degree of academic research, appears to have a significant negative effect on innovation output in a region.

2.4 However, universities are not only important contributors to economic development in regions where R&D intensive companies "pull" on them to exploit their output of ideas and people. They are also[5] key catalysts for economic development in regions where there has hitherto been no R&D intensive industry, provided that regional government and economic development agencies support excellence in basic/strategic research within the university and collaborate with it in strategic planning.

2.5 There is thus both operational benefit and broad political support for the powerful basic research capacity that exists in US research universities, not only in science, technology and medicine, but also in the social sciences, arts and humanities. That basic research power is reflected in the pre-eminence of US academics in the lists of winners of Nobel (Box 5) and other prizes in the last half century, and in lists of highly cited papers. The excellence and disciplinary breadth of the research effort in US research-intensive universities, coupled with strong funding, both from federal funds and their own endowments, gives them the capacity rapidly to reconfigure their research efforts, and to hire talent from any source, in order to pursue unexpected research opportunities. As a result, they are frequently leaders in areas of new knowledge and discovery.

Box 5 Relative numbers of Nobel Prize Winners in Physics, Chemistry, Physiology and Medicine



2.6 Many governments now recognise the value of research-intensive universities operating at the international leading edge for the direct products of their research, for the skills of people

4. Varga, Attila. 1998. University research and regional innovation: a spatial econometric analysis of academic technology transfers. *Economics of Science, Technology and Innovation*, vol. 13, Boston, Kluwer Academic. Based on a study in the US of the 125 "Metropolitan Statistical Areas" which analyses the impact of R&D expenditure and in particular of university research.

5. Etzowitz, 1994. Science and Public Policy

educated at the frontiers of knowledge and for the creative processes described in paragraph 2.1 and 2.2. Very recently, it has led countries such as Singapore and China to shift their policies by investing more in basic research, research-based training and in the development of research-intensive universities that will be best able to fulfil these complementary roles.

THE COMPARATIVE EUROPEAN PERFORMANCE IN R & D

3.1 Although we advocate the case for basic research across the whole range of science, technology, the social sciences and humanities, and their importance for society, we concentrate in this section on science and technology. It is the area where statistics are most readily available, and where recent advances have led to overwhelmingly positive changes in economic prosperity and the quality of life. In making comparisons and determining policy, it is important to assess the productivity of the research/application system as a whole through:

a) the magnitude of investment and the balance between basic and applied research;
b) the output of research in terms of scientific papers and new knowledge;
c) the extent to which research findings are exploited.

Relevant statistics are shown in Box 6

Investment

3.2 Investment in R&D in Europe, both by government and industry, is low compared with the USA in relative terms and even lower in absolute terms. Industry is less R&D intensive, there are fewer researchers in the workforce and proportionately fewer PhD graduates in industry. The data produce a picture of a European economy that is significantly less research intensive and less innovative, that has grown at a significantly slower rate and where research funding is more than ten times less than in its US competitor.

3.3 In the USA, the top 25 universities have research budgets of $10.25 billion, of which 66% is won from Federal funds. In addition, their large endowments are in part used to fund research innovation. In Europe, FP6 has a budget of $4.1 billion pa. In the past, 33% of funding ($1.4 billion) has been spread thinly to a large number of Universities. We estimate that the top 25 universities in Europe receive research funds from all sources of about 10% of their US counterparts. This suggests, given Europe's proportionately larger number of PhD students than the USA, that funding of the research programmes and infrastructure on which European PhD students largely depend is much weaker than in the USA, and may be part of the explanation for low demand for PhD studies amongst the best European graduates.

Output of research and the creation of new knowledge

3.4 Although the production of scientific papers per million of the population in Europe is marginally smaller than in the USA, it represents strong productivity in relation to the number of researchers and the funding of research[6]. Similarly, although the number of highly cited papers from the US community is greater than from Europe, and the productivity of US science remains greater when the numbers of scientists are compared, European productivity is higher in relation to the level of financial investment.

6 R.M.May, The Scientific Investment of Nations. *Science*, 281, 49-51.

BOX 6 EU/USA RESEARCH BASE COMPARISONS

	EU-15	USA
Economic performance		
GDP in trillium $ US	9.6	101.1
Average annual percentage economic growth (1990-2000)	1.90%	3.50%
Research expenditure		
Total R & D expenditure as % of GDP	1.93	2.69
Total R & D expenditure in trillion $US	0.19	2.72
R & D spend per capita	$458	$1000
Proportion of R & D financed by industry	56%	68%
Industry financed R & D as % of industry output	1.49	2.09
Research base personnel		
Total number of graduates (in 1998)	1,990,668	2,066,595
Total number of researchers	919,796	1,219,407
Number of researchers per 1000 population	3.03	6.21
New S & T PhDs (age 25-34) per 1000 population	0.56	0.48
Researchers in industry(%)	50	83.3
Published output		
Number of scientific publications per million population	818	926
Highly cited papers as % of total publications	1.2	1.64
Highly cited papers per million population	31	50
Exploitation metrics		
Patents taken out in US	69	312
Patents taken out in Europe	125	130

OECD Basic Science & Technology Statistics

3.5 A key question however, relates to the source of truly ground breaking discoveries that come from research, and where the leading work in current cutting-edge research is located. There is no simple statistic that reflects this, but Box 5 evaluates it through a comparison of trends of the relative performance of Europe and the USA in the Nobel Prize competition. It suggests that the US predominance as world leaders in research is increasing. We suggest that in a global economy where industry is free to locate its activities and investment where it wishes, and where new companies based on innovative ideas capture global markets, this is a central issue. We conclude that although the productivity of European scientists is excellent, they are not given the tools they need to promote Europe to the leading position to which it aspires.

The exploitation of research

3.6 The research papers cited in applications for patents are primarily derived from universities, and the numbers of basic research papers so cited has increased in all sectors in recent years[5]. It is not surprising that US institutions dominate the number of patents taken out in the USA, but it is striking that US institutions also register more patents in Europe than European institutions (Box 6).

This may reflect relatively poor research awareness in European companies and the weaker role that research and innovation plays in their investment priorities. The capacity to exploit innovation irrespective of its source, and efficiently to exploit the research base are vital attributes of a competitive modern economy.

EUROPEAN RESEARCH-INTENSIVE UNIVERSITIES

4.1 The vitality and effectiveness of a research base depends upon three key factors: its capacity to attract clever people, adequate funding and a strong pull from users. Europe, is failing relatively in all three. People are vital parts of a research system:

- *on the supply side*, they are the creators of new knowledge and promote its use; it is vital that a research career is seen as attractive by the cleverest graduates;
- *on the demand side*, they are those educated in a research environment who work in the user community, can match needs to research solutions and are vital agents both in ensuring that research is efficiently exploited and, because of their market knowledge, as agents in helping to set the research agenda.

Interaction between researchers on the supply side and research-trained people on the demand side is crucial for an effective knowledge drive within society.

4.2 The key role played by research-intensive universities in these processes was analysed in LERU paper 1. The effectiveness of research universities in Europe is undermined by three systemic weaknesses:

a) Inadequate research funding and limited financial flexibility.

The level of funding for universities and for many key areas of research is low compared with that in the USA. In most European countries, government provides core funding of the university research infrastructure (salaries, laboratories etc). This infrastructure is then used to undertake focused research projects funded by research grants. Many funders, including the EU, medical charities and government do not cover the full costs of research, with the consequence that the greater the volume of research done by a university, the more its finances are drained. This, coupled with universities' desire to be internationally competitive, leads to severe "overtrading", a process that systematically undermines the capacity of Europe's best research universities to realise their potential[7]. As a consequence of their financial weakness, European universities lack the vital strategic flexibility perennially to re-configure their research efforts to pursue the leading edge of the international research agenda. At the same time, the competitiveness of international research is increasing as many countries increase their investment in research.

b) Poor support for research careers.

The relatively poor support for research, the surfeit of researchers in relation to available funding and the financial inflexibility of research-intensive universities makes research careers an unattractive option for the best graduates compared with the USA[8]. Furthermore, as the market for the best graduates becomes international, and as the USA and other countries increase their efforts to recruit them, Europe's universities must be able to compete more effectively in attracting them. Internationally competitive research cannot be done without internationally competitive researchers.

c) Weak pull from the demand side

The statistics summarised in Box 3 reveal low research intensiveness, and a weak pull on the research base from the private and public enterprises whose innovative capacity needs to be high if

7 The UK Treasury has recently surveyed the extent to which the full costs of university research are covered. They concluded that "overtrading" had led to a deficit of 41.5% in income relative to costs. *Cross-Cutting Review of Science and Research*, HM Treasury, 2002.

8 S.Mahroum. Europe and the challenge of the brain drain. IPTS Report 29.

European society is to prosper. Greater investment in R&D must remain a vital priority for Europe. In the many regions where there is no R&D intensive industry to pull on the research base, it is important to recognise the potential for universities to act as catalysts for economic development, but the realisation of this potential requires strong collaboration between regional government and university and support for high international standards in research in the latter.

INTERNATIONALLY PRE-EMINENT RESEARCH-INTENSIVE UNIVERSITIES – A VITAL POLICY OBJECTIVE FOR A EUROPE OF KNOWLEDGE

5.1 Research-intensive universities are arguably the most efficient means of creating a world-leading research base and can be powerful drivers of economic development. They have fundamental strengths that have been the engine of success of US research and that highly focused virtual networks or single institutes lack. They are a vital part of the infrastructure for a modern society through the ideas and opinions they create and the people they attract to work in them. They are powerful attractors for modern industry. Just as capital has become internationally mobile, so are the best students and the best researchers. It is important that policies are developed in Europe to enable the development of between 50 and 100 internationally competitive research-intensive universities to act the essential catalysts for a "Europe of Knowledge" and as attractive international beacons for people, innovation and industry. The key issues for such a policy are listed below.

Increased funding

5.2 The key priority is for European governments to commit themselves to increase the level of research funding to the 3% of GDP proposed by the European Commission. It should provide the infrastructure that will permit leading edge research to be undertaken. Any such increase should not merely be used for a pro rata increase in the number of researchers, but should be used to increase the level of funding per researcher so that excellent researchers can address the most challenging problems.

Correcting the balance

5.3 The balance in European research has tipped too far towards strategic and away from basic research. A significant part of any increase in research funding should prioritise basic research to re-stimulate the creativity that comes from basic research and that also energises and inspires strategic and applied research. In addition, the EU Framework programmes should be amended to include basic research, and EU competence should be extended to research *per se*, rather than merely through its competence for competition policy. Funding must be competitively allocated on the basis of quality and not of a *juste retour*.

Recreating strategic flexibility

5.4 Research universities must be enabled to re-create the strategic flexibility to pursue opportunities as they arise, through full funding of research, that avoids "over-trading" and on a full cost-plus basis to create strategic headroom. The means whereby this could be done need to be discussed further, but it is a vital priority. Taxation rules should be amended to encourage tax-efficient giving.

The careers of young researchers

5.5 It should be a priority to create a cohort of excellent, ambitious and well supported researchers that will form the backbone of European research well into the 21st century. Attracting the best graduates into research and creating an environment in which their research flourishes both depend upon: adequate funding for world class infrastructure, ambitious projects, good salaries and good career structures that enable them to learn with the best research groups and permit them to develop, through extended fellowships and good funding, powerful independent research programmes. The purpose of such research training should not merely be to replenish the ranks of researchers in universities and research institutes, but also to encourage and enhance the flow of good researchers into industry and the public services. The EU should fund a substantial number of elite fellowships for young researchers. A possible model for them could be the UK Royal Society Research Fellowships. These have been enormously successful in created a cohort of clever, highly professional researchers who are now beginning to strengthen university research. They could be based on European collaborations and require holders to work in collaborating laboratories.

Stimulating economic development

5.6 The European Union aspires to be the world's leading knowledge-based economy by 2010 (Lisbon). This cannot be realized unless Europe has a world leading research base, industry for which the capacity to exploit research is a vital part of its competitive armoury and effective mechanisms for interaction between them. Research-based innovation most readily leads to economic development where R&D intensive industry pulls strongly on the research base, and where the links are between companies and the university. However, in regions where there is no such industry, research "push" from the university into business can be a key catalyst in the creation of a more mature economic base. This however requires a tripartite relationship between regional government, industry and university, in which a shared strategy is based on mutual recognition of the distinctive contributions of each partner and an appropriate interface is created between the universities research activity and industrial application[9].

5.7 One of the current barriers at the interface between industry and universities is the ownership of intellectual property rights. Universities will naturally wish to exploit IPR to their own financial benefit, particularly if there are financially weak, which is not necessarily to the benefit of the regional or national economy. This dilemma could be resolved, and permit IPR to flow more readily into exploitation, if there were a formulaic allocation of funds to the university based on its contribution to economic development measured through an appropriate metric.

9 Etkowitz, H. 2002. *MIT and the Rise of Entrepreneurial Science*. London: Routlidge.

APPENDIX - Research-Intensive Universities within a University System

A1 The above paper has made the case for the research intensive university as fulfilling one distinctive role of the diverse range expected of modern universities. Their capacity to respond to such a diverse range of needs is however based on a common ethos and tradition; of the aspiration of merit-based entry, both for staff and students, of the search for new knowledge, of scepticism and of intellectual freedom. These values have permitted academics individually to develop and promote new ideas that have made the university a source of diverse creativity that no prescriptively managed organization can rival. Students educated in such a setting acquire these values and habits, which are vital to a democracy and its pursuit of cultural, social and economic objectives.

A2 However, the diversity of roles that universities are now called upon to play can no longer be efficiently supported within a single institution. We need a university system, in which all institutions have the generic attributes described in paragraph A1, but which individually focus their activities in different parts of the spectrum, and are able to collaborate effectively across it. The concepts of the European Higher Education Area and the European Research Area cannot be effectively developed without articulating the desirable spectrum of university roles in Europe. The two end-points and the intervening mid-point of such a spectrum might be:

a) Universities that offer highly vocational education in restricted or broadly-defined fields supported by appropriate applied research and with strong links to industry, commerce and the public sector in its region.
b) Universities specialising in undergraduate and taught masters education but with some doctoral research, that sustain a sufficiently broad disciplinary range to permit curricular flexibility and evolution, and with a commitment to scholarship that ensures that teaching is based on experience and not second hand knowledge;
c) Research-intensive universities that are major contributors (in some cases, the major contributor) to national basic research efforts, that are principal sources of the next generation of researchers, with a very high proportion of taught postgraduate and doctoral training, and that aspire to the very highest international standards of research and research-based teaching (see LERU paper 1).

These are all vital university roles. They must not be seen as a hierarchy of excellence but as a system of excellence in diversity.